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Characteristics of online medical care consultation for pregnant women during the COVID-19 outbreak: a cross-sectional study

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Abstract

Background: During the Coronavirus Disease 2019 (COVID-19) outbreak, emergency traffic bans limited accessibility of some medical resource for pregnant women. Fear of viral transmission also prevented pregnant women from seeking routine antenatal care (ANC).

Objectives: This study described the needs of pregnant women and the contents of online obstetric consultation in representative areas with various severity of the epidemic in China.

Methods: From February 10th to 23rd, we collected data on online obstetric consultations and women’s satisfaction in mild, moderate and severe epidemic areas through an e-health provider’s platform. Information on women’s needs, contents of the consultation and satisfaction were collected and compared by epidemic areas.

Results: A total of 2599 pregnant women participated in this study, of whom 448, 1322 and 819 women were from the mild, moderate and severe epidemic areas, respectively. The distributions of the amount of online consultation were significantly different not only in different areas, but also in different trimesters. The more severe the epidemic was and the more advanced the pregnancy was, the higher the amount of second category (changed their schedules of ANC and/or delivery as well as method of delivery) was. 957 participants completed a satisfaction survey. For most of the participants, it’s their first time to use the e-health, and nearly 90% participants were completely or mostly satisfied with the online consultation.

Conclusions: Our study found that during the outbreak, many pregnant women had changed their scheduled ANC visits without authorization, and the more serious the epidemic was, the more common it occurred. The needs for online consultation was substantial. In order to prevent irreversible obstetric adverse events, an appropriate ANC contingency plan with e-health services is highly recommended during the Public Health Emergency of International Concern (PHEIC).

Keywords: COVID-19; pregnant women; antenatal care; e-health

Strengths and limitations

1. According to the epidemic condition, 6 representative areas were chosen in our study, what's more, Wuhan as the epidemic centre was also included.
2. Due to the geographical location and different severity of the epidemic, Chongqing (a nearby city, less affected but still in the outbreak), and Xinjiang, Gansu (relatively remote areas, almost unaffected) are both good Comparisons (Figure 1 and Figure 2).
3. Nevertheless, there are some limitations should be considered. Firstly, self-report bias might exist in our design. Secondly, there may be bias as the satisfaction questionnaire was not a commonly structured scale. Thirdly, sample size were not similar, but multiple centres were involved to minimize biases.

Background

Since December 2019, a number of unexplained cases of viral pneumonia have been found in Wuhan, Hubei province.^[1] By January 7, 2020, Chinese scientists had isolated the novel coronavirus, which has been later termed as severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2). The official name of the related disease is COVID-19.^[2] Since 10 a.m. on January 23, 2020, traffic bans in Wuhan has been established and the whole city has been temporarily locked down.^[3] Subsequently, first-level emergency responses to public health emergencies have been launched successively throughout China. As of April 8, 2020, the number of confirmed cases of COVID-19 globally reached 1,384,146, of which 83,157 cases were confirmed in China, especially in Hubei province (67,803 confirmed cases).

Pregnant women are considered to be susceptible to this virus.^[4] For pregnant women, the routine ANC during pregnancy is very important, by which high-risk pregnant women can be screened as soon as possible.^[5,6] However, the maternal ANC encountered great challenges during the COVID-19 outbreak due to limited accessibility of some medical resource caused by emergency traffic bans, and the risk of viral transmission. In the clinical, we noticed that some highly recommend antenatal check-ups had been canceled or postponed beyond its opportune gestational age by many pregnant women. And the recent studies have mainly

focus on the therapeutic of pregnant women with COVID-19. Little was discussed about maternal ANC during the COVID-19 outbreak.^[7-9]

E-health refers to the integration of medical services and medical information through the Internet and mobile technologies, such as computers, mobile phones, handheld tablets, and other wireless devices.^[10,11] Compared with developed countries, e-health started relatively late in China.^[12,13] Previous reports have shown that the number of mobile phone users worldwide is nearly 7.7 billion, which equals to the total population in the world.^[14] By June 2019, only 5.27% internet users had used the “Internet+medical” (45 million).^[15] The YueYiTong (YueYiTong Science and Technology Co., Ltd. in Chongqing, China) has set up an online communication platform for hospitals and pregnant women specially. Currently, it has been applied in many domestic comprehensive medical institutions to provide health consultation and online services for the pregnant women. So far, it has 54,303 registered users. During the COVID-19 outbreak, an online medical model that allows pregnant women to consult professional obstetricians without leaving home has been rapidly developed by YunYiTong (YYT, a platform built by YueYiTong).

In this study, we focused on the specific content of online obstetric consultation for pregnant women during the COVID-19 outbreak based on the platform (YYT). To further investigate the role of e-health, we also conducted a survey on pregnant women who consulted online to understand their satisfaction with this consultation service and their future needs for e-health .

Methods

Study design and participants

This study was a descriptive, cross-sectional study. We collected data from two aspects including contents of pregnant women's online obstetric consultation and satisfaction. Gestational age and satisfaction survey were collected from registration information and satisfaction questionnaire, respectively. The content of satisfaction questionnaire was reviewed by obstetricians (Hongbo Qi and Xin Luo). Several ways were performed to promote the free online service for obstetric consultation provided by YYT, including forwarding the link of the online medical consultation service website to colleagues and friends and distributing the free online treatment information. Within a few days after it was

launched, the free online treatment mode had attracted over 800 maternal-fetal medicine specialists in 347 hospitals nationwide. Every pregnant woman had access to the free online treatment after registration on the platform, and can choose obstetricians or hospitals at will. When a patient consults a doctor, the platform will prompt the doctor to reply within 24 hours. Before the consultation, the pregnant women would be informed that the contents of consultation would be used for scientific research and the platform promised that the contents would be kept absolutely confidential. After the consultation, the platform would distribute a satisfaction questionnaire, which would take 2 minutes to complete, but pregnant women could choose whether to answer or not. The study started from February 10, 2020 to February 23, 2020.

All pregnant women, who had submitted their online obstetric consultation, were eligible for inclusion. The cross-sectional study was approved by the ethics committee of the First Affiliated Hospital of Chongqing Medical University (20200501), and all the methods were performed in accordance with the relevant guidelines and regulations.

Procedures

According to the map of national COVID-19 confirmed cases and the data we collected from each province, Xinjiang, Gansu (10-99 confirmed cases), Chongqing (100-999 confirmed cases), Hubei, Henan, and Hunan (≥ 1000 confirmed cases) were chosen as representative areas (Figure 1 and Figure 2). In this study, the number of confirmed cases of COVID-19 in different areas was used to assess the severity of epidemics. Hence, according to the confirmed cases, Hubei, Henan and Hunan were defined as the severe epidemic areas. Chongqing was defined as the moderate epidemic area for more confirmed cases than Xinjiang and Gansu (the mild epidemic areas).

Data collection were conducted automatically and all data in our study were reviewed and classified independently by two authors (MMC and XYL). The data was sorted by different areas or different trimesters of pregnancy using manual classification method after the exclusion of unqualified data. The specific process of exclusion was shown in Figure 3.

According to gestational age, participants in each representative area were divided into three gestational periods: (1) the first trimester: <14 weeks, (2) the second trimester: from 14 weeks to 27 weeks and 6 days, (3) the third trimester: ≥ 28 weeks. At the same time, contents of

online obstetric consultations were then subdivided into five primary categories: (1) Routine antenatal check-up (reports of examination, appointments for antenatal check-up, method and time of delivery, and hospitalization process; (2) Obstetric care-seeking behaviour (cancel or postpone scheduled ANC visits; change method or time of delivery); (3) Abnormal symptoms (vaginal bleeding, abnormal fetal movement, abdominal pain, etc.); (4) Maternal comorbidity and pregnancy complication (gestational diabetes mellitus, hypertension disorders, hypothyroidism, etc.); (5) Other needs of e-health (remote fetal heart monitoring, electronic prescription, online pharmacies).

Since the satisfaction questionnaire was not a commonly structured scale, all the 7 questions have been analyzed separately. The questionnaire is shown in [Appendix 1](#). Through the satisfaction questionnaire, we intend to understand the “4P” situation during the COVID-19 outbreak in different areas: (1) Percentage of users who use e-health for the first time; (2) Proportion of problems solved by YYT; (3) Pregnant women’s satisfaction with e-health; (4) Preference to e-health vs outpatient visits during and after the outbreak of COVID-19 outbreak.

Statistical analysis

All exact numbers and percentages for all variables were calculated, and all the comparisons were performed using Chi-squared test. The SPSS software, version 24.0 was used for the statistics analysis, and the conventional *p* value less than 0.05 is defined as statistically significant. Percentage (%) was used to express categorical variable.

Result

A total of 2599 participants participated in this study, of whom 448, 1322 and 819 women were from the mild, moderate and severe epidemic areas, respectively. Among all the participants, 417, 1054 and 1128 were in their first, second and third trimester of pregnancy, respectively. It was worth noting that it was the first time e-health was used in perinatal health care during the COVID-19 outbreak, and 6.77% of participants generated additional requirements for e-health, such as: remote fetal heart rate monitoring, electronic prescription, online pharmacies.

Reasons for online consultation by areas with different severity of the epidemic (Table 1).

The distribution of the amount of online consultation varied by areas with different severity of the epidemic ($p < 0.01$). And there was 32.48% of pregnant women consulted the second category (obstetric care-seeking behaviour) in the most severe areas, which was significantly higher than the average value of 22.58%.

Table 1: Reasons for online consultation by areas with different severity of the epidemic.

Classification of online medical care consultation	The severity of the epidemic situation in different areas			Total	χ^2	P-value
	Mild (n=448)	Moderate (n=1332)	Severe (n=819)			
Routine antenatal check-up	184(41.07)	561(42.12)	263(32.11)	1008(38.78)		
Obstetric care-seeking behaviour	91(20.31)	229(17.19)	266(32.48)	586(22.55)		
Abnormal symptoms	110(24.55)	292(21.92)	143(17.46)	545(20.97)	86.216	0.000**
Maternal comorbidity and pregnancy complications	46(10.27)	158(11.86)	80(9.77)	284(10.93)		
Other needs for e-health	17(3.79)	92(6.91)	67(8.18)	176(6.77)		

Note: Data are n (%); Chi-squared test was used for the analysis; * $p < 0.05$ ** $p < 0.01$.

Reasons for online consultation by trimesters of pregnancy (Table 2).

The difference was shown in the distribution of the amount of online consultation by trimesters ($p < 0.05$). This difference might be related to the distribution of the amount of online consultation on the first two categories. The first category (routine antenatal check-up) was of highest concern in the first trimester (57.31%), compared to that in the second (39.75%) and third trimester (31.03%). While the distribution of the amount of online consultation on the second category in different trimester was completely opposite to that on the first category. And the second category had attracted the most attention from pregnant women in the third trimester (25.18%) .

Table 2: Reasons for online consultation by trimesters of pregnancy.

Classification of online medical care consultation	Trimesters of pregnancy			Total	χ^2	P-value
	First trimester (n=417)	Second trimester (n=1054)	Third trimester (n=1128)			
Routine antenatal check-up	239(57.31)	419(39.75)	350(31.03)	1008(38.78)	151.335	0.000**
Obstetric care-seeking behaviour	45(10.79)	257(24.38)	284(25.18)	586(22.55)		
Abnormal symptoms	74(17.75)	211(20.02)	260(23.05)	545(20.97)		
Maternal comorbidity and pregnancy complications	28(6.71)	75(7.12)	181(16.05)	284(10.93)		
Other needs for e-health	31(7.43)	92(8.73)	53(4.70)	176(6.77)		

Note: Data are n (%); Chi-squared test was used for the analysis. * $p<0.05$ ** $p<0.01$.

Reasons for online consultation by the trimesters of gestation and the severity of the epidemic (Table 3).

In this study, most participants were in the second or third trimester (40.55%, 43.40%). Therefore, the data of the first trimester had certain limitations in this study. Regardless of the trimesters, the distribution of the amount of online consultation was region-dependent ($p<0.05$). In any trimester, the more severe the epidemic in different regions became, the greater the amount of consultations on the second category (obstetric care-seeking behaviour) would be. And the proportions of the second category in the second and third trimesters were 36.51% and 37.88% separately, while the corresponding average values were 24.38% and 25.18%.

The most concerned category during different trimesters (Figure 4).

Generally, in any area, or during any trimester, routine antenatal check-up, obstetric care-seeking behaviour, and abnormal symptoms were the top three consulted categories. In the first trimester, pregnant women in different regions were the most frequently consulting for the first type of problems, which was consistent with that in the second and third trimester both in the moderate and mild epidemic areas. However, in the severe epidemic areas, the

second category (Obstetric care-seeking behavior) was of most concern in the second and third trimesters of pregnancy.

Table 3: Reasons for online consultation by the trimesters of gestation and the severity of the epidemic.

Classification of online medical care consultation	The severity of the epidemic situation in different areas			Total	χ^2	P-value
	Mild (n=448)	Moderate (n=1332)	Severe (n=819)			
First trimester				417 (16.04)	33.422	0.000**
Routine antenatal check-up	36(58.06)	125(69.06)	78(44.83)	239(57.31)		
Obstetric care-seeking behaviour	8(12.90)	11(6.08)	26(14.94)	45(10.79)		
Abnormal symptoms	16(25.81)	25(13.81)	33(18.97)	74(17.75)		
Maternal comorbidity and pregnancy complications	2(3.23)	8(4.42)	18(10.34)	28(6.71)		
Other needs for e-health	0(0.00)	12(6.63)	19(10.92)	31(7.43)		
Second trimester				1054 (40.55)	48.869	0.000**
Routine antenatal check-up	86(45.99)	231(41.85)	102(32.38)	419(39.75)		
Obstetric care-seeking behaviour	44(23.53)	98(17.75)	115(36.51)	257(24.38)		
Abnormal symptoms	34(18.18)	133(24.09)	44(13.97)	211(20.02)		
Maternal comorbidity and pregnancy complications	11(5.88)	38(6.88)	26(8.25)	75(7.12)		
Other needs for e-health	12(6.42)	52(9.42)	28(8.89)	92(8.73)		
Third trimester				1128 (43.40)	52.766	0.000**
Routine antenatal check-up	62(31.16)	205(34.22)	83(25.15)	350(31.03)		
Obstetric care-seeking behaviour	39(19.60)	120(20.03)	125(37.88)	284(25.18)		
Abnormal symptoms	60(30.15)	134(22.37)	66(20.00)	260(23.05)		
Maternal comorbidity and pregnancy complications	33(16.58)	112(18.70)	36(10.91)	181(16.05)		
Other needs for e-health	5(2.51)	28(4.67)	20(6.06)	53(4.70)		

Note: Data are n (%); Chi-squared test was used for the analysis. * $p < 0.05$ ** $p < 0.01$.

Participants experience with e-health (Table 4).

A total of 957 participants completed the satisfaction questionnaire, of whom 164,644,149 were from the mild, moderate and severe epidemic areas respectively. During the outbreak of COVID-19, we wanted to learn the following four aspects of the situation in different regions ("4P") from the questionnaire. The first is the percentage of users who use e-health for the first time. Surprisingly, for most of the participants, it was their first time to use the e-health, with the highest rate of 89.26% in the severely epidemic areas. The second is proportion of problems solved by the platform. We found that more than 90% of online consultation issues were completely or partially resolved. The third is pregnant women's satisfaction with e-health. In fact, the proportion of total satisfaction or relative satisfaction was the lowest in severe epidemic areas, at 87.92%, while it was as high as 90% in other areas. The last was Preference to e-health or outpatient visits during and after the outbreak. Undoubtedly, the outbreak of COVID-19 had an obvious impact on participants' choices. During the outbreak of COVID-19, most participants preferred to use e-health (the lowest rate of 88.41% in the mild epidemic areas), while, about half of participants chose the outpatient visits after the outbreak, which was most popular in moderate epidemic areas, with the highest rate of 62.11%. The advantages of e-health are saving time and reducing the risk of viral transmission. As for their suggestions for e-health in the near future, most pregnant women hoped that the platform would automatically recommend the most suitable obstetrician based on the their consultations. Some participants expressed more needs for e-health, such as remote fetal heart monitoring, electronic prescription, and online pharmacies, etc..

Table 4: Satisfaction questionnaire

	The severity of the epidemic in different areas			Total	χ^2	P-value
	Mild	Moderate	Severe			
First time using e-health	164	644	149	/	20.178	0.000**
No	27(16.46)	168(26.09)	16(10.74)	211(22.05)		
Yes	137(83.54)	476(73.91)	133(89.26)	746(77.95)		

The degree of trouble shooting	164	644	149	/	23.274	0.001**
Completely solved	124 (75.61)	521(80.90)	98(65.77)	743(77.64)		
Largely solved	34(20.73)	115(17.86)	42(28.19)	191(19.96)		
Barely solved	4(2.44)	6(0.93)	6(4.03)	16(1.67)		
Not solved at all	2(1.22)	2(0.31)	3(2.01)	7(0.73)		
The degree of satisfaction with e-health	164	644	149	/	22.015	0.005**
Completely satisfaction	109(66.46)	438(68.01)	82(55.03)	629(65.73)		
Mostly satisfied	43(26.22)	175(27.17)	49(32.89)	267(27.90)		
satisfaction						
neutral attitude	11(6.71)	25(3.88)	14(9.40)	50(5.22)		
Mostly satisfied	1(0.61)	0(0.00)	2(1.34)	3(0.31)		
dissatisfaction						
Completely dissatisfaction	0(0.00)	6(0.93)	2(1.34)	8(0.84)		
Choice (during the COVID-19)	164	644	149	/	1.147	0.563
E-health	145(88.41)	576(89.44)	137(91.95)	858(89.66)		
Outpatient	19 (11.59)	68(10.56)	12(8.05)	99(10.34)		
Choice (after the COVID-19)	164	644	149	/	11.145	0.004**
E-health	85(51.83)	244(37.89)	66(44.30)	395(41.27)		
Outpatient	79(48.17)	400(62.11)	83(55.70)	562(58.73)		
Convenience of the e-health^M	395	1613	351	/	6.821	0.556
Time -saving	124 (75.61)	535 (83.07)	106 (71.14)	765 (79.94)		
Risk-reduction@	127 (77.44)	534 (82.92)	128 (85.91)	789 (82.45)		
Cost- saving	71 (43.29)	268 (41.61)	55 (36.91)	394 (41.17)		
Feeling more relax	64 (39.02)	258 (40.06)	59 (39.60)	381 (39.81)		
Others	9 (5.49)	18 (2.80)	3 (2.01)	30 (3.13)		
Needs for e-health^M	285	1087	248	/	14.474	0.070
Online video	67(23.51)	198(18.22)	50(20.16)	315 (32.92)		
Physician's replay within a defined time	52(18.25)	173(15.92)	45(18.15)	270 (28.21)		
Automatic referral to appropriate obstetricians	83(29.12)	370(34.04)	96(38.71)	549 (57.37)		
Management of maternal medical condition	79(27.72)	318(29.25)	53(21.37)	450 (47.02)		
Others#	4(1.40)	28(2.58)	4(1.61)	36 (3.76)		

Note: Data are n (%); Chi-squared test was used for the analysis;
** $p<0.05$ ** $p<0.01$.*
M: multiple choice allowed
Risk-reduction[@]: risk-reduction of being infected with COVID-19 by avoiding extra exposure.
Others[#]: remote fetal heart monitoring, electronic prescription, or online pharmacies.

Discussion

The COVID-19 outbreak represents a significant and urgent threat to global health. On 30 January 2020, COVID-19 has been declared as “public enemy number one” and “a very high level of global risk” by WHO.^[16,17] As of March 23, 186 countries worldwide had reported confirmed COVID-19 cases, including more than 10,000 confirmed cases in America, Germany, France, Italy and Iran. In this study, many pregnant women were found postponing or canceling their scheduled ANC visits on their own, which was related to the severity of the epidemic situation in different areas, especially in the severe epidemic areas. Meanwhile, the needs of pregnant women for e-health have exceeded our expectation. Data showed that more than 15,000 consultations were conducted through the platform till March 15 . To the best of our knowledge, this is the first time to focus on the characteristics of online obstetric consultation for pregnant women during the COVID-19 outbreak.

Changes in obstetric care-seeking behaviour during the COVID-19 outbreak.

In our study, we discussed the associations between the distribution of the amount of online consultation and trimesters or the severity of the epidemic in different area. The distribution of the amount of online consultation were significantly different not only in different areas, but also in different trimesters. The more severe the epidemic was and the more advanced the pregnancy was, the higher the percentage of second category (changed their schedules of ANC and/or delivery as well as method of delivery) was. During the COVID-19 outbreak, emergency traffic bans limited accessibility of some medical resource for pregnant women, and fear of viral transmission also prevented pregnant women from seeking routine ANC, especially in severe epidemic areas. All of these phenomena can explain the cause of the highest concern of second category in the areas with severe epidemic. Unlike the first and the second trimester, the need for more frequent ANC in the third trimester is already a huge challenge for pregnant women.^[18] In our hospitals, there were 16,120 outpatient visits in

Obstetrics Clinic of the First Affiliated Hospital of Chongqing Medical University in last February, compared with 6,859 in February 2020. Furthermore, this difference was more dramatic in Maternal and Child Health Hospital of Hubei Province, because more than 21,000 outpatient visits were reduced in February 2020, compared with that of last February (27254 visits VS 5410 visits). The sharp decline of outpatient visits further reflected that pregnant women postponed or canceled scheduled ANC visits on their own. This phenomenon raised our concerns over a series of potential irreversible obstetric adverse events.

Significance of ANC.

In order to detect maternal complications, reduce adverse pregnancy events and promote doctor-patient communication, 8 “contacts” is recommended between a pregnant woman and a healthcare provider according to WHO.^[19,20] Referring to the ANC guideline developed by America, Britain, Canada, and WHO, based on Chinese condition, *Guideline of Preconception and Prenatal Care (2018)* which was released by Chinese Medical Association, Chapter of Perinatal Medicine (the corresponding author, Professor Qi, is included) recommends 7-11 “contacts”. If there are high risk factors, the frequency should be increased appropriately. This guideline is widely applied by almost all domestic ANC institutions in China. Benefiting from the widespread application of the ANC guideline, birth defects and cesarean section rates have been reduced, and many other adverse pregnancy outcomes have been avoided in China.^[21-27] Nevertheless, during the COVID-19 outbreak, the routine ANC for pregnant women who are considered to be susceptible are extremely challenged.^[28,29] In the past month, a dramatic decline in ANC visit and an increase in the caesarean section rate had been observed by obstetricians, and all of which could lead to irreversible obstetrical pregnancy outcome. The phenomenon might related to the delayed detection of fetal malformation and a significant increasing incidence of diabetes, macrosomia and obesity due to lack of nutritional interventions or routine physical activities. What’s more, some pregnant women wanted to be hospitalized earlier to wait for the onset of labour or to have a cesarean in advance driven by an idea that as time went on, the chance of infection would increase. On the other hand, some pregnant women with indications of hospitalization blindly refused to be hospitalized for fear of infection with COVID-19. To prevent irreversible obstetric adverse events, some highly recommended antenatal check-ups must be conducted on time, and when

it comes to conduct ultrasound examination for confirming intrauterine pregnancy and Nuchal Translucency (NT) measurement, screening for foetal aneuploidy, oral glucose tolerance test (OGTT), etc., pregnant women have to visit hospital in person. And prompt hospitalization were highly recommended in the following circumstances, approaching terminal gestational age, pregnancy with severe maternal medical condition, with signs of labor, etc..

A novel mode of ANC plan with full application of e-health.

In our survey, most of the participants were the first time to experience e-health. What’s more, 91.95% pregnant women reported that they preferred e-health rather than a visit to hospital during the COVID-19 outbreak in the severe epidemic areas. The majority of pregnant women were completely or comparatively satisfied with e-health, and most of online obstetric consultations were completely or mostly solved. Except the second category, most pregnant women are more likely to consult about the first and third category, which probably due to the familiarity of e-health among the public. This result was consistent with the report of China Internet network information center (CNNIC) in June 2019.^[13] Actually, the “e” in e-health not only stands for “electronic”, but also means telemedicine, telecare, clinical information systems, and other non-clinical systems used for education, public health, medical management and so on.^[30] E-health has made some achievements in the management of chronic diseases such as diabetes and hypertension disorders.^[31,32] The application of e-health in obstetrics is mainly reflected in the abortion of unplanned pregnancy in the first trimester.^[33] The popularity of wearable devices promotes quantitative health management.^[34] Nevertheless, “e-health” cannot save everything. Some highly recommended antenatal check-ups and timely hospitalization are still necessary. Our domestic clinical ANC guideline is divided into health education and guidance, routine health care and auxiliary examination.^[18] According to the investigation of online obstetric consultation during the COVID-19 outbreak, we recommend to combine e-health with the ANC guideline in the following three aspects: (1) management of mental health, routine health education and care, authoritative prevention education on PHEs; (2) auxiliary procedures done through e-health for necessary check-ups recommended in hospital by obstetricians, such as making appointments, consulting examination reports etc.; (3) interventions of some maternal medical conditions performed through e-health, including gestational diabetes mellitus, hypertension

disorders, etc., which had been fully applied in non-pregnant people.^[31] We hold that the full application of e-health and prenatal care is highly recommended to be included in the contingency ANC plan during PHEs, which will be beneficial for pregnant women and mitigate the risk of adverse pregnancy outcomes.

Conclusions

Our study revealed that online obstetric consultation is highly accepted and satisfied by the pregnant women during the COVID-19 outbreak in China. This investigation also indicated that e-health has played an important role in ANC during PHE. This novel model of ANC plan can make notable contributions not only in China, but also in other emerging epidemic centers worldwide and in future PHEs.

List of abbreviations

Coronavirus Disease 2019 :COVID-19;

Antenatal care: ANC;

“YunYiTong WeChat terminal service” : YYT;

Public Health Emergency of International Concern: PHEIC;

severe acute respiratory syndrome coronavirus 2: SARS-CoV-2;

World Health Organization: WHO;

China Internet network information center: CNNIC.

Declarations

Ethics approval and consent to participate

The cross-sectional study was approved by the ethics committee of the First Affiliated Hospital of Chongqing Medical University (20200501).

Consent for publication

We followed guidelines ensuring the study was voluntary and confidential, and an electronic informed consent was obtained before the questionnaire.

Availability of data and materials

The datasets used and analysed during the current study are available from the corresponding author on reasonable request.

Competing interests

The authors declare that they have no competing interests

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Authors' contributions

HBQ, XL and MMC contributed to the protocol design. MMC and XYL collected and analyzed data. MMC drafted the manuscript, JZ, GQS, YG, YS, and PB contributed to the interpretation of results. JZ and YXZ proofread and commented on the manuscript. HBQ and XL revised the final version and are guarantors of this manuscript. All authors made substantial contributions to the paper and read and approved the final manuscript.

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Figure 1: The map of confirmed cases of COVID-19 in China on February 23

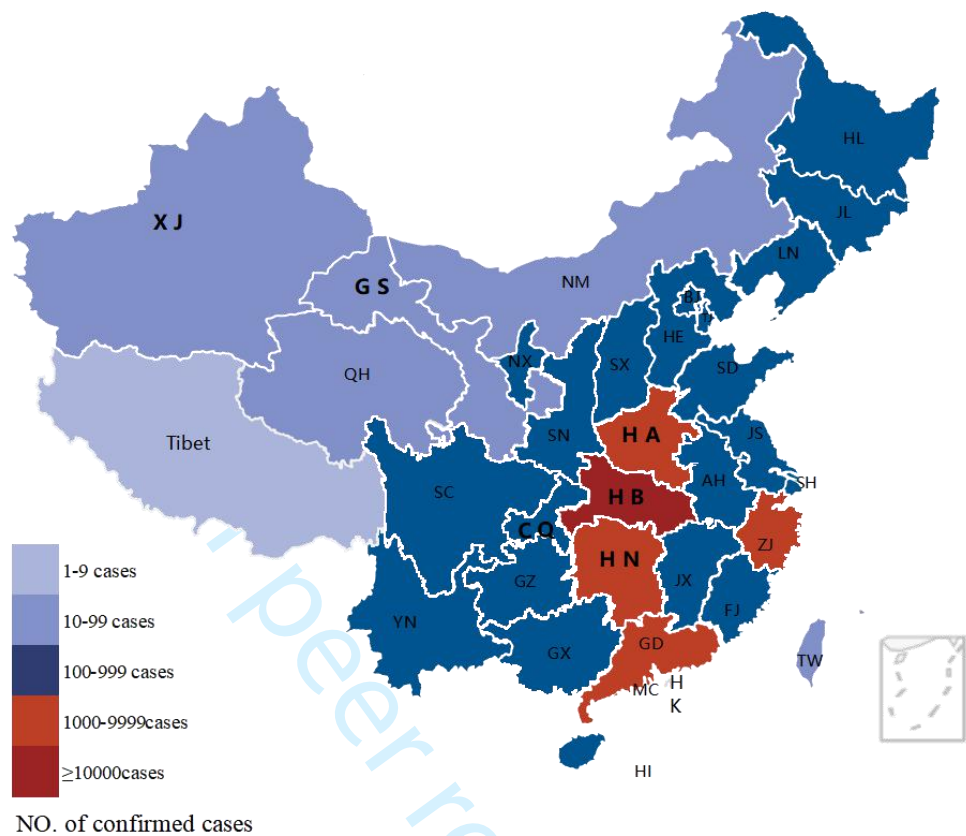


Figure 2: The map of participants' number in our study

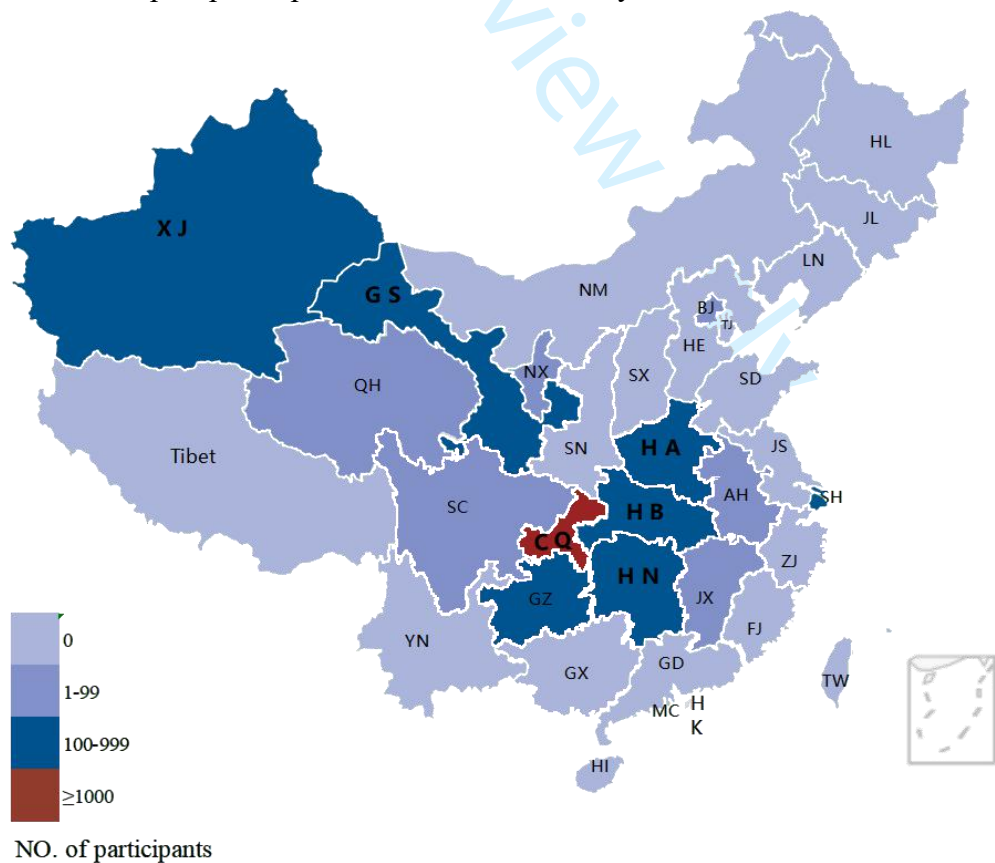
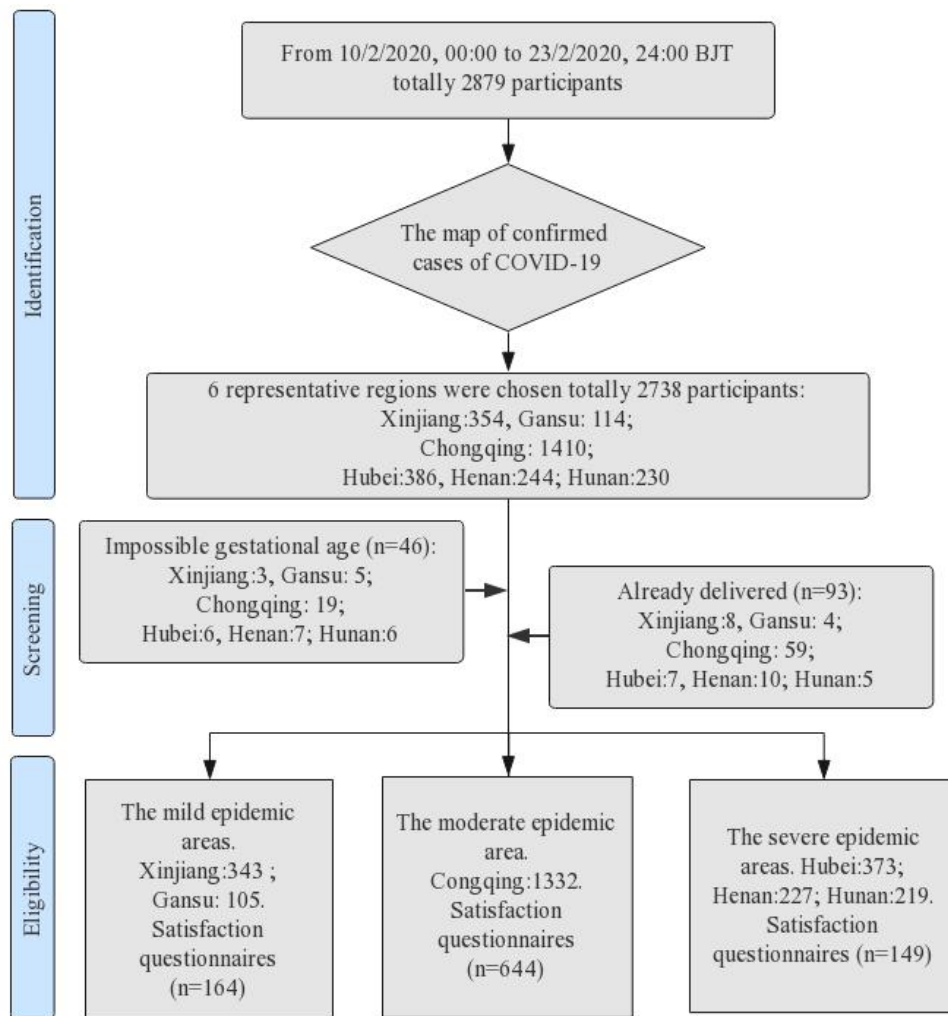


Figure 3: Process of classification and exclusion.



Percentage of participants in different areas

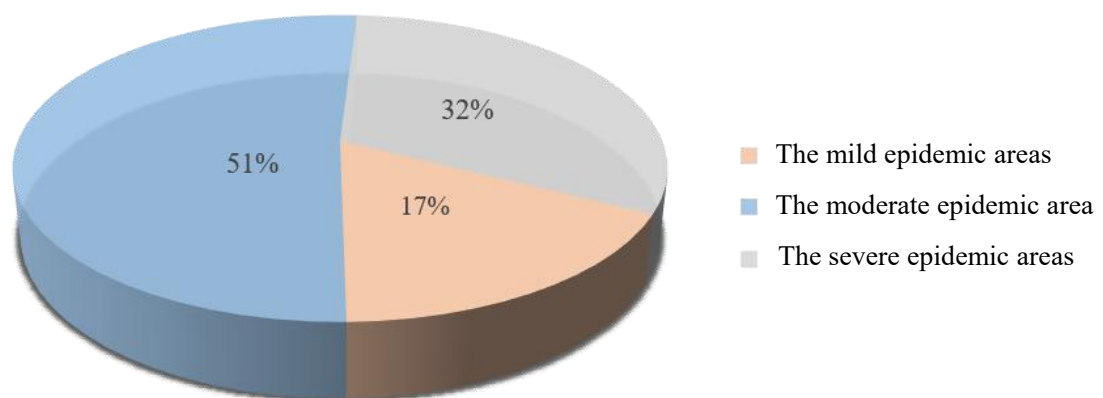
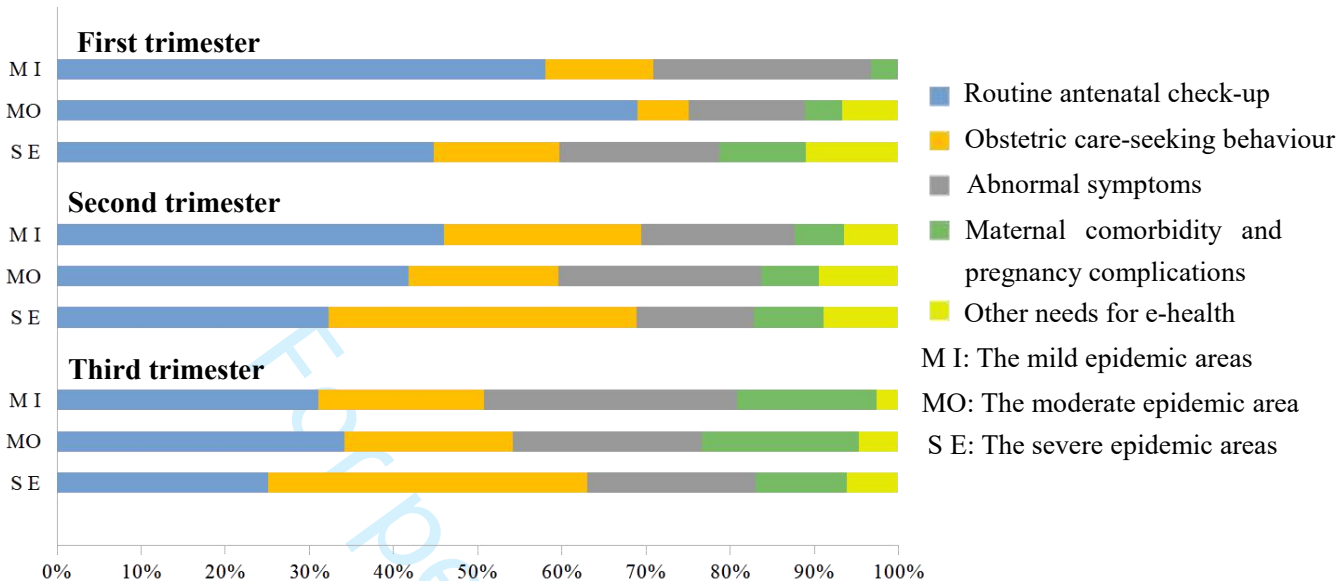


Figure 4: The proportion of the 5 categories by trimesters in each area



Characteristics of online medical care consultation for pregnant women during the COVID-19 outbreak: a cross-sectional study

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Appendix 1: Satisfaction questionnaire survey

Notice:

- 1. This is the translated version (from Chinese to English) of the questionnaire.
- 2. This is merely the main content of the questionnaire, not covering the brief introduction, the tips for filling in and the acknowledgments.
- 3. Unless otherwise mentioned, the questions are single-choice questions with options below or blank-filling questions with a horizontal line.

1. Is you first time using e-health ?

- A: Yes
- B: No

2. Had your online medical consultation been solved ?

- A: Completely solved
- B: Largely solved
- C: Barely solved
- D: Not solved at all

3. Are you satisfied with this online medical service?

- A: Completely satisfaction
- B: Mostly satisfaction
- C: Neutral attitude
- D: Mostly dissatisfaction
- E: Completely dissatisfaction

4. What convenience do you think e-health brings to you? (multiple choices)

- A: Time -saving
- B: Reducing risk of being infected with COVID-19
- C: Cost- saving
- D: Feeling more relax

5. What other functions do you hope e-health can provide for you? (multiple choices)

- A: Online video
- B: Physician’s replay within a defined time
- C: Automatic referral to appropriate obstetricians2
- D:Management of chronic diseases (diabetes, hypertension disorders, etc.)
- E:Others (remote fetal heart monitoring, electronic prescription, or online pharmacies)

6. During the outbreak of COVID-19, which one do you prefer ?

- A: E-health
- B: outpatient

7. After the COVID-19, which one do you prefer ?

- A: E-health
- B: outpatient

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Characteristics of online medical care consultation for pregnant women during the COVID-19 outbreak: a cross-sectional study

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Characteristics of online medical care consultation for pregnant women during the COVID-19 outbreak: a cross-sectional study

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32 Abstract

33 **Objectives:** This study described the needs of pregnant women and the contents of online
34 obstetric consultation in representative areas with various severity of the epidemic in China.

35 **Design:** This was a cross- sectional study.

36 **Setting:** YueYiTong (YYT), a free online communication platform that allows pregnant
37 women to consult professional obstetricians.

38 **Participants:** All the pregnant women who used the YYT platform.

39 **Intervention:** From February 10th to 23rd, we collected data on online obstetric consultations
40 and participants' satisfaction through YYT platform in the mild, moderate and severe
41 epidemic areas which were defined according to the local confirmed cases. The primary
42 outcomes were the reasons for online consultation by the severity of the epidemic. All the
43 comparisons were performed using Chi-squared test. Statistical analysis was performed using
44 SPSS V.24.

45 **Results:** A total of 2599 pregnant women participated in this study, of whom 448 (17.24%),
46 1332 (51.25%) and 819 (31.51%) women were from the mild, moderate and severe epidemic
47 areas, respectively. The distributions of the amount of online consultation were significantly
48 different not only in different areas ($p<0.001$), but also in different trimesters ($p<0.001$). Total
49 of 957 participants completed the satisfaction part of the survey. In this study, 77.95% of the

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50 participants used e-health for the first time, and 94.63% participants were completely or
51 mostly satisfied with the online consultation.

52 **Conclusions:** The distributions of the amount of online consultations were significantly
53 different not only in different areas, but also in different trimesters. In any trimester, the
54 amount of consultations on the second category (obstetric care-seeking behaviour) was the
55 highest in the severe epidemic areas. The needs for online consultation was substantial. In
56 order to prevent irreversible obstetric adverse events, an appropriate antenatal care (ANC)
57 contingency plan with e-health services is highly recommended during the Public Health
58 Emergency of International Concern (PHEIC).

59
60 **Keywords:** COVID-19; pregnant women; antenatal care; e-health

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63 **Strengths and limitations**

- 64 1. We collected these data during the most hopeless phase throughout the outbreak in China,
65 and the data of Hubei province was also included.
- 66 2. Due to the geographical location and different severity of the epidemic, Chongqing (a
67 nearby city, less affected but still in the outbreak), and Xinjiang, Gansu (relatively remote
68 areas, almost unaffected) are both good comparisons ([Figure 1](#) and [Figure 2](#)).
- 69 3. This study is the cross-sectional designed with the short duration of the data collection.
- 70 4. There may be bias as the satisfaction questionnaire was not a commonly structured scale.
- 71 5. Sample size of each area was not similar, but multiple centers were involved to minimize
72 biases.

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74 Background

75 Since December 2019, a number of unexplained cases of viral pneumonia have been found in
76 Wuhan, Hubei province.^[1] By January 7, 2020, Chinese scientists had isolated the novel
77 coronavirus, which has been later termed as severe acute respiratory syndrome coronavirus 2
78 (SARS-CoV-2). The official name of the related disease is COVID-19.^[2] Since 10 a.m. on
79 January 23, 2020, traffic bans in Wuhan has been established and the whole city has been
80 temporarily locked down.^[3] Subsequently, first-level emergency responses to public health
81 emergencies have been launched successively throughout China. As of April 8, 2020, the
82 number of confirmed cases of COVID-19 globally reached 1,384,146, of which 83,157 cases
83 were confirmed in China, especially in Hubei province (67,803 confirmed cases).

84 Pregnant women are considered to be susceptible to this virus.^[4] For pregnant women, the
85 routine ANC during pregnancy is very important, by which high-risk pregnant women can be
86 screened as soon as possible.^[5,6] However, the maternal ANC encountered great challenges
87 during the COVID-19 outbreak due to limited accessibility of some medical resources caused
88 by emergency traffic bans, and the risk of viral transmission. In the clinical setting, we
89 noticed that some highly recommend antenatal check-ups had been canceled or postponed
90 beyond its opportune gestational age by many pregnant women. And the recent studies have
91 mainly focused on the therapeutic of pregnant women with COVID-19. Little was discussed
92 about maternal ANC during the COVID-19 outbreak.^[7-9]

93 E-health refers to the integration of medical services and medical information through the
94 Internet and mobile technologies, such as computers, mobile phones, handheld tablets, and
95 other wireless devices.^[10,11] Compared with developed countries, e-health started relatively
96 late in China.^[12,13] Previous reports have shown that the number of mobile phone users
97 worldwide is nearly 7.7 billion, which equals to the total population in the world.^[14] By June
98 2019, only 5.27% internet users had used the “Internet+medical” (45 million).^[15] The
99 YueYiTong (YueYiTong Science and Technology Co., Ltd. in Chongqing, China) has set up
100 an online communication platform that allows pregnant women to consult professional
101 obstetricians without leaving home for hospitals.^[16]

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In this study, we focused on the specific content of online obstetric consultation for pregnant women during the COVID-19 outbreak based on the platform (YYT). To further investigate the role of e-health, we also conducted a survey on pregnant women who consulted online to understand their satisfaction with this consultation service and their future needs for e-health .

Methods

Study design and participants

This study was a descriptive, cross-sectional study. We collected data from two aspects including contents of pregnant women's online obstetric consultation and satisfaction. Gestational age and satisfaction survey were collected from registration information and satisfaction questionnaire, respectively. The content of satisfaction questionnaire was reviewed by obstetricians (Hongbo Qi and Xin Luo).

The free online service for obstetric consultation provided by YYT was promoted through several ways, including forwarding the link of the online medical consultation service website to colleagues and friends and distributing the free online treatment information. Within a few days after it was launched, the free online treatment mode had attracted over 800 maternal-fetal medicine specialists in 347 hospitals nationwide. Every pregnant woman had access to the free online treatment after registration on the platform, and can choose obstetricians or hospitals at will. When a patient consults a doctor, the platform will prompt the doctor to reply within 24 hours. Before the consultation, the pregnant women were informed that the contents of the consultation would be used for scientific research and be kept absolutely confidential. If they chose "I already know and agree to the above", they can continue their free online consultation. After the consultation, the platform would distribute a satisfaction questionnaire, which would take 2 minutes to complete, but pregnant women could choose whether to answer or not. The study started from February 10, 2020 to February 23, 2020.

All pregnant women, who had submitted their online obstetric consultation, were eligible for

inclusion. The cross-sectional study was approved by the ethics committee of the First Affiliated Hospital of Chongqing Medical University (20200501), and all the methods were performed in accordance with the relevant guidelines and regulations.

Procedures

According to the map of national COVID-19 confirmed cases and the data we collected from each province, Xinjiang, Gansu (10-99 confirmed cases), Chongqing (100-999 confirmed cases), Hubei, Henan, and Hunan (≥ 1000 confirmed cases) were chosen as representative areas (Figure 1 and Figure 2). In this study, the number of confirmed cases of COVID-19 in different areas was used to assess the severity of epidemics (Table S1). Hence, according to the confirmed cases, Hubei, Henan and Hunan were defined as the severe epidemic areas. Chongqing was defined as the moderate epidemic area for more confirmed cases than Xinjiang and Gansu (the mild epidemic areas).

Data collection were conducted automatically and all data in our study were reviewed and classified independently by two authors (MMC and XYL). The data was sorted by different areas or different trimesters of pregnancy using manual classification method after the exclusion of unqualified data. The specific process of exclusion was shown in Figure 3.

Impossible gestational age was identified whenever last menstrual or current gestational age showing less than 0 week or more than 45 weeks gestational age. According to gestational age, participants in each representative area were divided into three gestational periods: (1) the first trimester: <14 weeks, (2) the second trimester: from 14 weeks to 27 weeks and 6 days, (3) the third trimester: ≥ 28 weeks. At the same time, contents of online obstetric consultations were then subdivided into five primary categories: (1) Routine antenatal check-up (reports of examination, appointments for antenatal check-up, method and time of delivery, and hospitalization process; (2) Obstetric care-seeking behaviour (cancel or postpone scheduled ANC visits; change method or time of delivery); (3) Abnormal symptoms (vaginal bleeding, abnormal fetal movement, abdominal pain, etc.); (4) Maternal comorbidity and pregnancy complication (gestational diabetes mellitus, hypertension disorders, hypothyroidism, etc.); (5) Other needs of e-health (remote fetal heart monitoring, electronic

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prescription, online pharmacies).

Since the satisfaction questionnaire was not a commonly structured scale, all the 7 questions have been analyzed separately. The questionnaire is shown in Appendix 1. Through the satisfaction questionnaire, we intend to understand the “4P” situation during the COVID-19 outbreak in different areas: (1) Percentage of users who use e-health for the first time; (2) Proportion of problems solved by YYT; (3) Pregnant women’s satisfaction with e-health; (4) Preference to e-health vs outpatient visits during and after the outbreak of COVID-19 outbreak.

Statistical analysis

All exact numbers and percentages for all variables were calculated, and the comparisons were performed using Chi-squared test. Logistic regression was used to examine the association between the distribution of the amount of online consultations and the trimesters. The SPSS software, version 24.0 was used for the statistics analysis, and the conventional *p* value less than 0.05 is defined as statistically significant. Percentage (%) was used to express categorical variable.

Patient and Public Involvement

We didn’t directly include patient and public involvement in the study.

Result

A total of 2599 participants participated in this study, of whom 448 (17.24%), 1332 (51.25%) and 819(31.51%) women were from the mild, moderate and severe epidemic areas, respectively. Among all the participants, 417(16.04%), 1054(40.55%) and 1128(43.40%) were in their first, second and third trimester of pregnancy, respectively. It was worth noting that it was the first time e-health was used in ANC during the COVID-19 outbreak, and 6.77% of participants generated additional requirements for e-health, such as: remote fetal heart rate monitoring, electronic prescription, online pharmacies.

Reasons for online consultation by areas with different severity of the epidemic.

As shown in [table 1](#), the distribution of the amount of online consultation varied by areas with different severity of the epidemic ($p < 0.001$). And there was 32.48% of pregnant women consulted the second category (obstetric care-seeking behaviour) in the most severe areas, which was significantly higher than the average value of 22.58% ([Table 1](#)).

Table 1: Reasons for online consultation by areas with different severity of the epidemic.

Classification of online medical care consultation	The severity of the epidemic situation in different areas			Total	χ^2	P-value
	Mild	Moderate	Severe			
	(n=448)	(n=1332)	(n=819)			
Routine antenatal check-up	184(41.07)	561(42.12)	263(32.11)	1008(38.78)		
Obstetric care-seeking behaviour	91(20.31)	229(17.19)	266(32.48)	586(22.55)		
Abnormal symptoms	110(24.55)	292(21.92)	143(17.46)	545(20.97)	86.216	$p < 0.001^{**}$
Maternal comorbidity and pregnancy complications	46(10.27)	158(11.86)	80(9.77)	284(10.93)		
Other needs for e-health	17(3.79)	92(6.91)	67(8.18)	176(6.77)		

*Note: Data are n (%); Chi-squared test was used for the analysis; * $p < 0.05$ ** $p < 0.01$.*

Reasons for online consultation by trimesters of pregnancy.

In [table 2](#), the difference was shown in the distribution of the amount of online consultation by trimesters ($p < 0.01$). The first category (routine antenatal check-up) was of highest concern in the first trimester (57.31%), compared to that in the second (39.75%) and third trimester

(31.03%). While the distribution of the amount of online consultation on the second category in different trimester was completely opposite to that on the first category. And the second category had attracted the most attention from pregnant women in the third trimester (25.18%). Compared with the distribution of the amount of online consultations on the first category, the second (OR=1.265, 95% CI 1.044 to 1.532), third (OR=1.380, 95% CI 1.134 to 1.680), and forth category (OR=2.639, 95% CI 2.031 to 3.429) were associated with the trimesters of pregnancy (Table 2).

Table 2: Reasons for online consultation by trimesters of pregnancy.

	Trimesters of pregnancy			Total	OR (95% CI)	P-value
	First	Second	Third			
	trimester	trimester	trimester			
	(n=417)	(n=1054)	(n=1128)			
Classification of online medical care consultation						<i>p<0.001**</i>
Routine antenatal check-up	239(57.31)	419(39.75)	350(31.03)	1008(38.78)	Reference(1)	
Obstetric care-seeking behaviour	45(10.79)	257(24.38)	284(25.18)	586(22.55)	1.265 (1.044 to 1.532)	0.016
Abnormal symptoms	74(17.75)	211(20.02)	260(23.05)	545(20.97)	1.380 (1.134 to 1.680)	0.001
Maternal comorbidity and pregnancy complications	28(6.71)	75(7.12)	181(16.05)	284(10.93)	2.639 (2.031 to 3.429)	<i>p<0.001**</i>
Other needs for e-health	31(7.43)	92(8.73)	53(4.70)	176(6.77)	0.742 (0.533 to 0.984)	0.039

Note: Data are n (%); OR, odds ratio; CI, confidence interval; * *p*<0.05 ** *p*<0.01.

Reasons for online consultation by the trimesters of gestation and the severity of the epidemic.

In this study, as shown in [table 3](#), most participants were in the second or third trimester (40.55%, 43.40%). Regardless of the trimesters, the distribution of the amount of online consultation was region-dependent ($p < 0.001$). In any trimester, the amount of consultations on the second category (obstetric care-seeking behaviour) was the highest in the severe epidemic areas. And the proportions of the second category in the second and third trimesters were 36.51% and 37.88% separately, while the corresponding average values were 24.38% and 25.18% ([Table3](#)).

The most concerned category during different trimesters.

Generally, in any area, or during any trimester, routine antenatal check-up, obstetric care-seeking behaviour, and abnormal symptoms were the top three consulted categories ([Figure 4](#)). In the first trimester, pregnant women in different regions were the most frequently consulting for the first type of problems, which was consistent with that in the second and third trimester both in the moderate and mild epidemic areas ([Figure 4](#)). However, in the severe epidemic areas, the second category (Obstetric care-seeking behavior) was of most concern in the second and third trimesters of pregnancy ([Figure 4](#)).

Table 3: Reasons for online consultation by the trimesters of gestation and the severity of the epidemic.

Classification of online medical care consultation	The severity of the epidemic situation in different areas			Total	χ^2	P-value
	Mild	Moderate	Severe			
	(n=448)	(n=1332)	(n=819)			
First trimester				417(16.04)	33.422	$p < 0.001^{**}$
Routine antenatal check-up	36(58.06)	125(69.06)	78(44.83)	239(57.31)		

Obstetric care-seeking behaviour	8(12.90)	11(6.08)	26(14.94)	45(10.79)
Abnormal symptoms	16(25.81)	25(13.81)	33(18.97)	74(17.75)
Maternal comorbidity and pregnancy complications	2(3.23)	8(4.42)	18(10.34)	28(6.71)
Other needs for e-health	0(0.00)	12(6.63)	19(10.92)	31(7.43)
Second trimester				1054(40.55) 48.869 $p<0.001^{**}$
Routine antenatal check-up	86(45.99)	231(41.85)	102(32.38)	419(39.75)
Obstetric care-seeking behaviour	44(23.53)	98(17.75)	115(36.51)	257(24.38)
Abnormal symptoms	34(18.18)	133(24.09)	44(13.97)	211(20.02)
Maternal comorbidity and pregnancy complications	11(5.88)	38(6.88)	26(8.25)	75(7.12)
Other needs for e-health	12(6.42)	52(9.42)	28(8.89)	92(8.73)
Third trimester				1128(43.40) 52.766 $p<0.001^{**}$
Routine antenatal check-up	62(31.16)	205(34.22)	83(25.15)	350(31.03)
Obstetric care-seeking behaviour	39(19.60)	120(20.03)	125(37.88)	284(25.18)
Abnormal symptoms	60(30.15)	134(22.37)	66(20.00)	260(23.05)
Maternal comorbidity and pregnancy complications	33(16.58)	112(18.70)	36(10.91)	181(16.05)
Other needs for e-health	5(2.51)	28(4.67)	20(6.06)	53(4.70)

*Note: Data are n (%); Chi-squared test was used for the analysis. * $p<0.05$ ** $p<0.01$.*

Participants experience with e-health

The participants' experience with e-health were summarized in [table 4](#). A total of 957

participants completed the satisfaction questionnaire, of whom 164(17.14%), 644(67.29%), 149(15.57%) were from the mild, moderate and severe epidemic areas respectively. During the outbreak of COVID-19, we wanted to learn the following four aspects of the situation in different regions ("4P") from the questionnaire. The first is the percentage of users who use e-health for the first time. Surprisingly, for most of the participants, it was their first time to use the e-health, with the highest rate of 89.26% in the severely epidemic areas. The second is proportion of problems solved by the platform. We found that more than 90% of online consultation issues were completely or partially resolved. The third is pregnant women's satisfaction with e-health. In fact, the proportion of total satisfaction or relative satisfaction was the lowest in severe epidemic areas, at 87.92%, while it was as high as 90% in other areas. The last was Preference to e-health or outpatient visits during and after the outbreak. Undoubtedly, the outbreak of COVID-19 had an obvious impact on participants' choices. During the outbreak of COVID-19, most participants preferred to use e-health (the lowest rate of 88.41% in the mild epidemic areas), while, about half of participants chose the outpatient visits after the outbreak, which was most popular in moderate epidemic areas, with the highest rate of 62.11%. An average of 79.94% participants deemed that e-health could save time, and 82.45% participants thought it could reduce the risk of COVID-19 infection. In addition, There were 39.81% and 41.17% participants held the view that e-health could make them feel comfortable and save money, respectively. As for their suggestions for e-health in the near future, there were 32.92%, 28.21%, 57.37%, and 47.02% participants hoped for the function of online video, physician's replay within a defined time, automatic referral to appropriate obstetricians, and management of maternal medical condition, respectively. There were 3.76% participants expressed more needs for e-health, such as remote fetal heart monitoring, electronic prescription, and online pharmacies, etc.

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257 Table 4: Satisfaction questionnaire.

The severity of the epidemic						
	in different areas			Total	χ^2	P-value
	Mild	Moderate	Severe			
First time using e-health	164	644	149	/	20.178	$p<0.001^{**}$
No	27(16.46)	168(26.09)	16(10.74)	211(22.05)		
Yes	137(83.54)	476(73.91)	133(89.26)	746(77.95)		
The degree of trouble shooting	164	644	149	/	23.274	0.001**
Completely solved	124(75.61)	521(80.90)	98(65.77)	743(77.64)		
Largely solved	34(20.73)	115(17.86)	42(28.19)	191(19.96)		
Barely solved	4(2.44)	6(0.93)	6(4.03)	16(1.67)		
Not solved at all	2(1.22)	2(0.31)	3(2.01)	7(0.73)		
The degree of satisfaction with e-health	164	644	149	/	22.015	0.005**
Completely satisfaction	109(66.46)	438(68.01)	82(55.03)	629(65.73)		
Mostly satisfied satisfaction	43(26.22)	175(27.17)	49(32.89)	267(27.90)		
neutral attitude	11(6.71)	25(3.88)	14(9.40)	50(5.22)		
Mostly satisfied dissatisfaction	1(0.61)	0(0.00)	2(1.34)	3(0.31)		
Completely dissatisfaction	0(0.00)	6(0.93)	2(1.34)	8(0.84)		
Choice (during the COVID-19)	164	644	149	/	1.147	0.563
E-health	145(88.41)	576(89.44)	137(91.95)	858(89.66)		
Outpatient	19 (11.59)	68(10.56)	12(8.05)	99(10.34)		
Choice (after the COVID-19)	164	644	149	/	11.145	0.004**
E-health	85(51.83)	244(37.89)	66(44.30)	395(41.27)		
Outpatient	79(48.17)	400(62.11)	83(55.70)	562(58.73)		
Convenience of the e-health^M	395	1613	351	/	6.821	0.556

Time -saving	124(75.61)	535(83.07)	106(71.14)	765(79.94)		
Risk-reduction@	127(77.44)	534(82.92)	128(85.91)	789(82.45)		
Cost- saving	71(43.29)	268(41.61)	55(36.91)	394(41.17)		
Feeling more relax	64(39.02)	258(40.06)	59(39.60)	381(39.81)		
Others	9(5.49)	18(2.80)	3(2.01)	30(3.13)		
Needs for e-health^M	285	1087	248	/	14.474	0.070
Online video	67(23.51)	198(18.22)	50(20.16)	315(32.92)		
Physician's replay within a defined time	52(18.25)	173(15.92)	45(18.15)	270(28.21)		
Automatic referral to appropriate obstetricians	83(29.12)	370(34.04)	96(38.71)	549(57.37)		
Management of maternal medical condition	79(27.72)	318(29.25)	53(21.37)	450(47.02)		
Others [#]	4(1.40)	28(2.58)	4(1.61)	36(3.76)		

Note: Data are n (%); * $p < 0.05$ ** $p < 0.01$; M: multiple choice allowed; Risk-reduction@: risk-reduction of being infected with COVID-19 by avoiding extra exposure. Others[#]: remote fetal heart monitoring, electronic prescription, or online pharmacies.

Discussion

The COVID-19 outbreak represents a significant and urgent threat to global health. On January 30, 2020, COVID-19 has been declared as “public enemy number one” and “a very high level of global risk” by WHO.^[17,18] As of March 23, 2020, 186 countries worldwide had reported confirmed COVID-19 cases, including more than 10,000 confirmed cases in America, Germany, France, Italy and Iran. In this study, many pregnant women were found postponing or canceling their scheduled ANC visits on their own, which was related to the severity of the epidemic situation in different areas, especially in the severe epidemic areas. Meanwhile, the needs of pregnant women for e-health have exceeded our expectation. Data showed that more than 15,000 consultations were conducted through the platform till March

15. To the best of our knowledge, this is the first time to focus on the characteristics of online obstetric consultation for pregnant women during the COVID-19 outbreak. Since the majority of participants in the study was in their second and third trimester, the data of the first trimester had certain limitations.

Changes in obstetric care-seeking behaviour during the COVID-19 outbreak.

In our study, we discussed the associations between the distribution of the amount of online consultation and trimesters or the severity of the epidemic in different area. The distribution of the amount of online consultations was significantly different not only in different areas, but also in different trimesters. We also found that in any trimester, the amount of consultations on the second category (obstetric care-seeking behaviour) was the highest in the severe epidemic areas. During the COVID-19 outbreak, emergency traffic bans limited accessibility of some medical resources for pregnant women, and fear of viral transmission also prevented pregnant women from seeking routine ANC, especially in severe epidemic areas. All of these phenomena can explain the cause of the highest concern of second category in the areas with severe epidemic. Unlike the first and the second trimester, the need for more frequent ANC in the third trimester is already a huge challenge for pregnant women.^[19] In our hospitals, there were 16,120 outpatient visits in Obstetrics Clinic of the First Affiliated Hospital of Chongqing Medical University in last February, compared with 6,859 in February 2020. Furthermore, this difference was more dramatic in Maternal and Child Health Hospital of Hubei Province, because more than 21,000 outpatient visits were reduced in February 2020, compared with that of last February (27254 visits VS 5410 visits). The sharp decline of outpatient visits further reflected that pregnant women postponed or canceled scheduled ANC visits on their own. This phenomenon raised our concerns over a series of potential irreversible obstetric adverse events.

Significance of ANC.

In order to detect maternal complications, reduce adverse pregnancy events and promote doctor-patient communication, 8 “contacts” is recommended during pregnancy according to WHO.^[20,21] Referring to the ANC guideline developed by America, Britain, Canada, and

WHO, based on Chinese condition, *Guideline of Preconception and Prenatal Care (2018)* which was released by Chinese Medical Association, Chapter of Perinatal Medicine recommends 7-11 “contacts”.^[19] If there are high risk factors, the frequency should be increased appropriately. This guideline is widely applied by almost all domestic ANC institutions in China. Benefiting from the widespread application of the ANC guideline, birth defects and cesarean section rates have been reduced, and many other adverse pregnancy outcomes have been avoided in China.^[22-28] Nevertheless, during the COVID-19 outbreak, the routine ANC for pregnant women who are considered to be susceptible are extremely challenged.^[29,30] In the past month, a dramatic decline in ANC visit and an increase in the cesarean section rate had been observed by obstetricians, and all of which could lead to irreversible obstetrical pregnancy outcome. The phenomenon might be related to the delayed detection of fetal malformation and a significant increasing incidence of diabetes, macrosomia and obesity due to lack of nutritional interventions or routine physical activities. What’s more, some pregnant women wanted to be hospitalized earlier to wait for the onset of labour or to have a cesarean in advance driven by an idea that as time went on, the chance of infection would increase. On the other hand, some pregnant women with indications of hospitalization blindly refused to be hospitalized for fear of infection with COVID-19. To prevent irreversible obstetric adverse events, some highly recommended antenatal check-ups must be conducted on time, and when it comes to conduct ultrasound examination for confirming intrauterine pregnancy and Nuchal Translucency (NT) measurement, screening for foetal aneuploidy, oral glucose tolerance test (OGTT), etc., pregnant women have to visit hospital in person. And prompt hospitalization were highly recommended in the following circumstances, approaching terminal gestational age, pregnancy with severe maternal medical condition, with signs of labor, etc..

A novel mode of ANC plan with full application of e-health.

In our survey, most of the participants were the first time to experience e-health. What’s more, 91.95% pregnant women reported that they preferred e-health rather than a visit to hospital during the COVID-19 outbreak in the severe epidemic areas. The majority of pregnant women were completely or comparatively satisfied with e-health, and most of online

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4 329 obstetric consultations were completely or mostly solved. Except the second category, most
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6 330 pregnant women are more likely to consult about the first and third category, which probably
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8 331 due to the familiarity of e-health among the public. This result was consistent with the report
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10 332 of China Internet network information center (CNNIC) in June 2019.^[13] Actually, the “e” in
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12 333 e-health not only stands for “electronic”, but also means telemedicine, telecare, clinical
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14 334 information systems, and other non-clinical systems used for education, public health,
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16 335 medical management and so on.^[10] E-health has made some achievements in the management
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18 336 of chronic diseases such as diabetes and hypertension disorders.^[31,32] The application of
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20 337 e-health in obstetrics is mainly reflected in the abortion of unplanned pregnancy in the first
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22 338 trimester. ^[33] The popularity of wearable devices promotes quantitative health
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24 339 management.^[34] Nevertheless, “e-health” cannot save everything. Some highly recommended
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26 340 antenatal check-ups and timely hospitalization are still necessary. Our domestic clinical ANC
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28 341 guideline is divided into health education and guidance, routine health care and auxiliary
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30 342 examination.^[19] According to the investigation of online obstetric consultation during the
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32 343 COVID-19 outbreak, we recommend to combine e-health with the ANC guideline in the
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34 344 following three aspects: (1) management of mental health, routine health education and care,
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36 345 authoritative prevention education on PHEs; (2) auxiliary procedures done through e-health
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38 346 for necessary check-ups recommended in hospital by obstetricians, such as making
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40 347 appointments, consulting examination reports etc.; (3) interventions of some maternal medical
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42 348 conditions performed through e-health, including gestational diabetes mellitus, hypertension
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44 349 disorders, etc., which had been fully applied in non-pregnant people.^[31] We hold that the full
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46 350 application of e-health and prenatal care is highly recommended to be included in the
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48 351 contingency ANC plan during PHEs, which will be beneficial for pregnant women and
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50 352 mitigate the risk of adverse pregnancy outcomes.

51 353 **Conclusions**

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54 354 Our study found that during the outbreak, many pregnant women changed their
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56 355 scheduled antenatal care (ANC) visits without authorization, especially in the severe
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58 356 epidemic areas. This study also revealed that online obstetric consultation is highly accepted
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60 357 and satisfactory to the pregnant women during the COVID-19 outbreak in China. This

investigation also indicated that e-health has played an important role in ANC during PHE. This novel model of ANC plan can make notable contributions not only in China, but also in other emerging epidemic centers worldwide and in future PHEs.

List of abbreviations

Coronavirus Disease 2019 : COVID-19;

Antenatal care: ANC;

“YunYiTong WeChat terminal service”: YYT;

Public Health Emergency of International Concern: PHEIC;

Severe acute respiratory syndrome coronavirus 2: SARS-CoV-2;

World Health Organization: WHO;

China Internet network information center: CNNIC.

Declarations

Ethics approval and consent to participate

The cross-sectional study was approved by the ethics committee of the First Affiliated Hospital of Chongqing Medical University (20200501).

Consent for publication

We followed guidelines ensuring the study was voluntary and confidential, and an electronic informed consent was obtained before the questionnaire.

Availability of data and materials

The datasets used and analysed during the current study are available from the corresponding author on reasonable request.

Competing interests

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Authors' contributions

HBQ, XL and MMC contributed to the protocol design. MMC and XYL collected and analyzed data. MMC drafted the manuscript, JZ (Jun Zhang), GQS, YG, YS, and PB contributed to the interpretation of results. JZ (Jing Zeng) and YXZ proofread and commented on the manuscript. HBQ and XL revised the final version and are guarantors of this manuscript. All authors made substantial contributions to the paper and read and approved the final manuscript.

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490 **Figure legend**

491 Figure 1: The map of confirmed cases of COVID-19 in China on February 23.

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493 Figure 2: The map of participants' number in our study.

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495 Figure 3: Process of classification and exclusion.

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497 Figure 4: The proportion of the 5 categories by trimesters in each area.

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Figure 1: The map of confirmed cases of COVID-19 in China on February 23

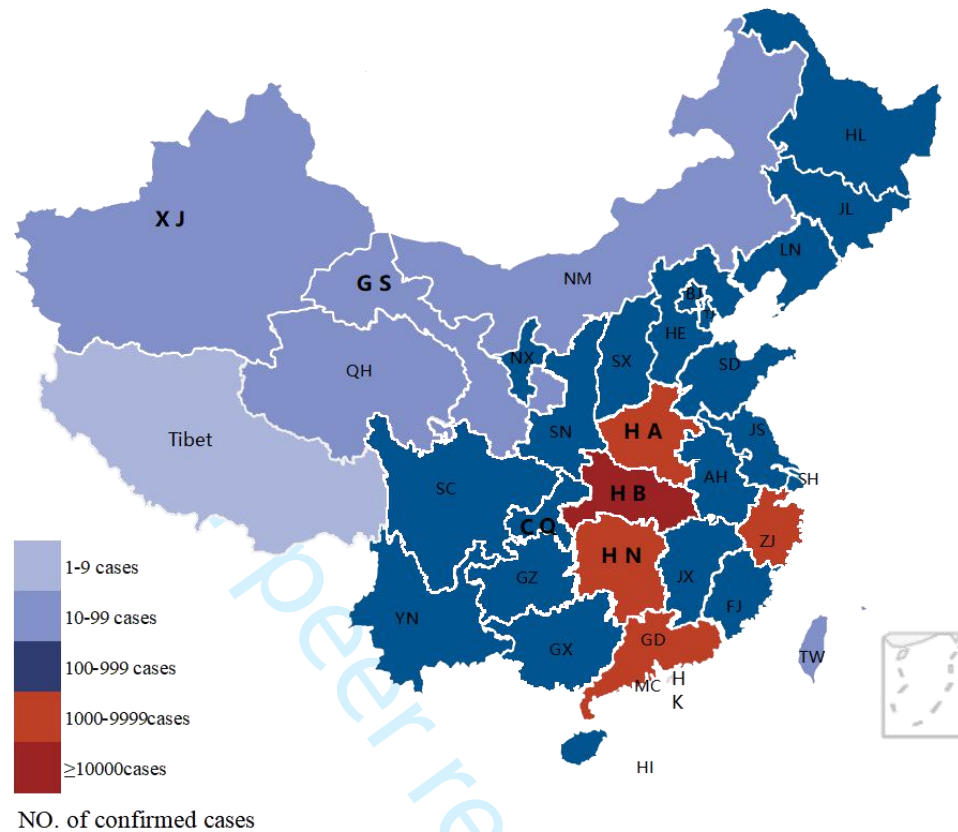


Figure 2: The map of participants' number in our study

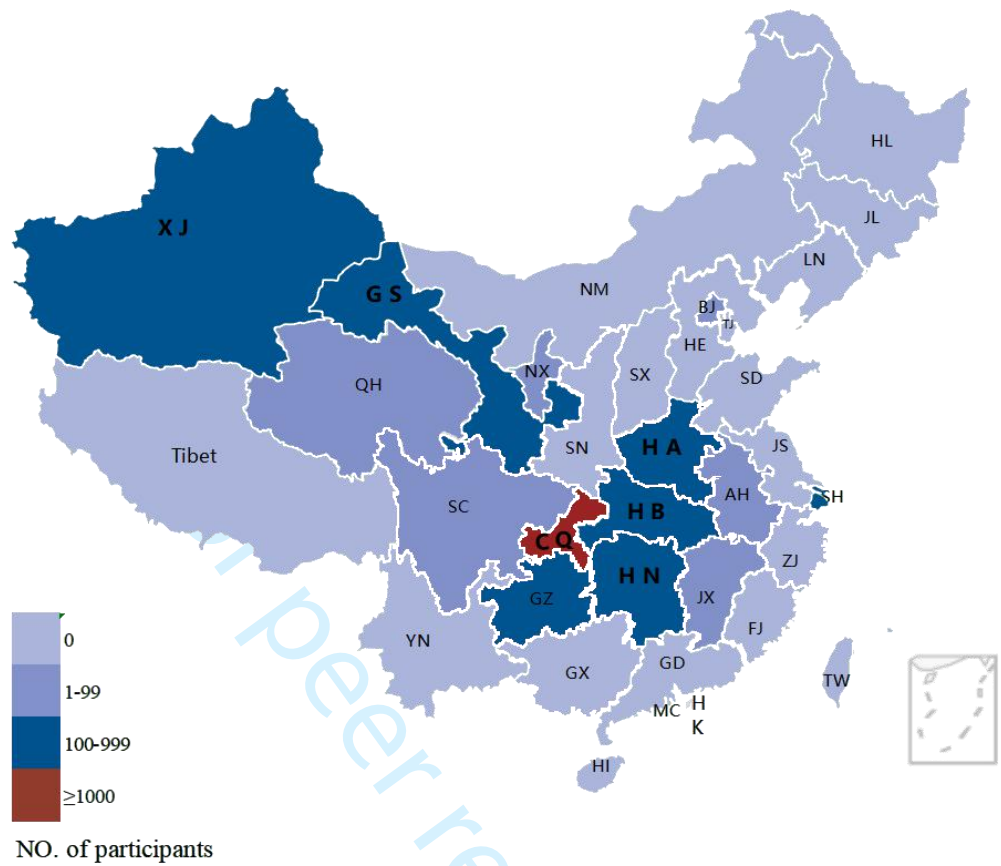


Figure 3: Process of classification and exclusion.

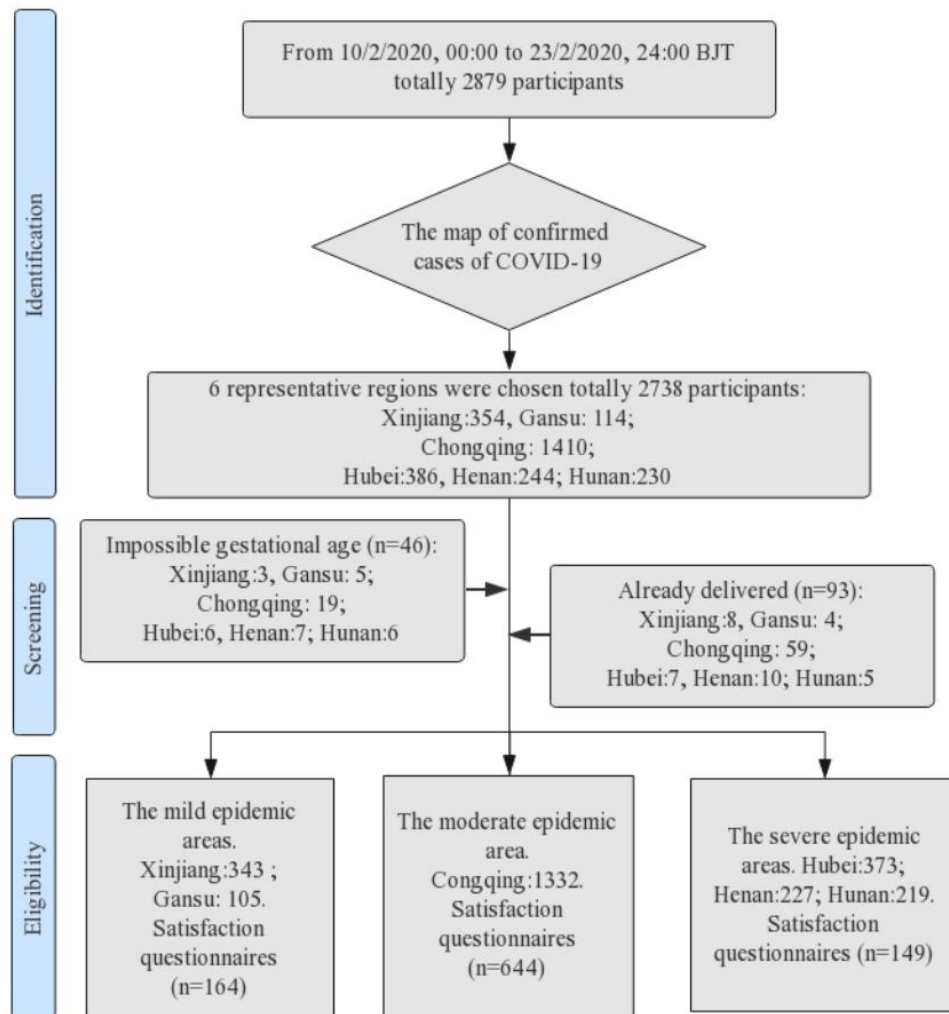


Figure 4: The proportion of the 5 categories by trimesters in each area

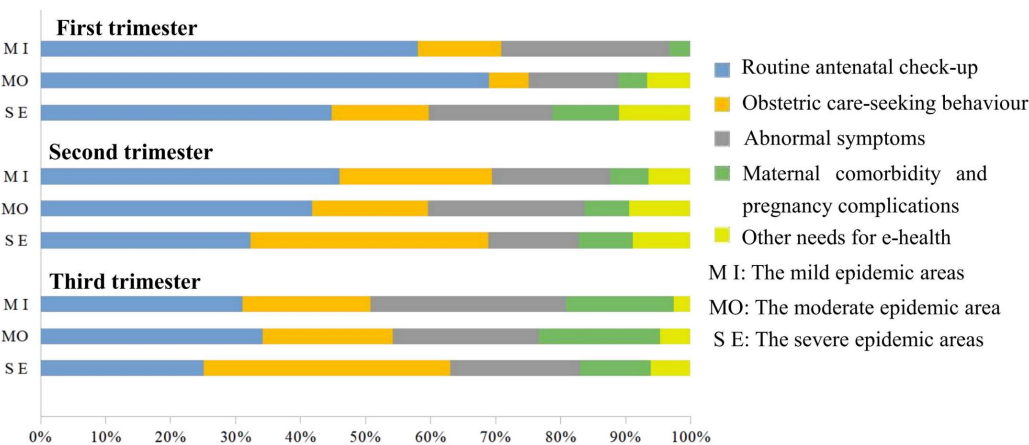


Table S1: confirmed cases in the selected areas as at the time of data collection.

The severity of the epidemic situation	Representative areas	Confirmed cases (cases)
Mild	Gansu	91
	Xinjiang	76
Moderate	Chongqing	575
	Hubei	64287
Severe	Henan	1271
	Hunan	1261

Characteristics of online medical care consultation for pregnant women during the COVID-19 outbreak: a cross-sectional study

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Appendix 1: Satisfaction questionnaire survey

Notice:

1. This is the translated version (from Chinese to English) of the questionnaire.
2. This is merely the main content of the questionnaire, not covering the brief introduction, the tips for filling in and the acknowledgments.
3. Unless otherwise mentioned, the questions are single-choice questions with options below or blank-filling questions with a horizontal line.

1. Is you first time using e-health ?

A: Yes

B: No

2. Had your online medical consultation been solved ?

A: Completely solved

B: Largely solved

C: Barely solved

D: Not solved at all

3. Are you satisfied with this online medical service?

A: Completely satisfaction

B: Mostly satisfaction

C: Neutral attitude

D: Mostly dissatisfaction

E: Completely dissatisfaction

4. What convenience do you think e-health brings to you? (multiple choices)

A: Time -saving

B: Reducing risk of being infected with COVID-19

C: Cost- saving

D: Feeling more relax

5. What other functions do you hope e-health can provide for you? (multiple choices)

A: Online video

B: Physician's replay within a defined time

C: Automatic referral to appropriate obstetricians²

D: Management of chronic diseases (diabetes, hypertension disorders, etc.)

E: Others (remote fetal heart monitoring, electronic prescription, or online pharmacies)

6. During the outbreak of COVID-19, which one do you prefer ?

A: E-health

B: outpatient

7. After the COVID-19, which one do you prefer ?

A: E-health

B: outpatient

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STROBE Statement—checklist of items that should be included in reports of observational studies

	Item No	Recommendation	
Title and abstract	1	(a) Indicate the study’s design with a commonly used term in the title or the abstract	Page 1, line 1-2
		(b) Provide in the abstract an informative and balanced summary of what was done and what was found	Page 2, line 32-57
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	Page 3, line 74-101
Objectives	3	State specific objectives, including any prespecified hypotheses	Page 3, line 102-105
Methods			
Study design	4	Present key elements of study design early in the paper	Page 2, line 60
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	Page 4-5, line 108-127;
Participants	6	(a) Cohort study—Give the eligibility criteria, and the sources and methods of selection of participants. Describe methods of follow-up	Page 5, line128-129.
		Case-control study—Give the eligibility criteria, and the sources and methods of case ascertainment and control selection. Give the rationale for the choice of cases and controls	
		Cross-sectional study—Give the eligibility criteria, and the sources and methods of selection of participants	
		(b) Cohort study—For matched studies, give matching criteria and number of exposed and unexposed	/
		Case-control study—For matched studies, give matching criteria and the number of controls per case	
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	Page 5, line 136-140;

Page 5-6,
line 145-157.

Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	Page 4, line 109-110; Page 5, line 141-144.
Bias	9	Describe any efforts to address potential sources of bias	Page 3, line 71
Study size	10	Explain how the study size was arrived at	Page 5, line 133-136
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	Page 6, line 166
Statistical methods	12	(a) Describe all statistical methods, including those used to control for confounding	Page 6, line 167-168
		(b) Describe any methods used to examine subgroups and interactions	Page 6, line 168
		(c) Explain how missing data were addressed	/
		(d) <i>Cohort study</i> —If applicable, explain how loss to follow-up was addressed	/
		<i>Case-control study</i> —If applicable, explain how matching of cases and controls was addressed	
		<i>Cross-sectional study</i> —If applicable, describe analytical methods taking account of sampling strategy	
		(e) Describe any sensitivity analyses	/

Continued on next page

Results

Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	Figure 3
		(b) Give reasons for non-participation at each stage	Figure 3
		(c) Consider use of a flow diagram	Figure 3

Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	Page 6, Line 175-178
		(b) Indicate number of participants with missing data for each variable of interest	Figure 3
		(c) <i>Cohort study</i> —Summarise follow-up time (eg, average and total amount)	
Outcome data	15*	<i>Cohort study</i> —Report numbers of outcome events or summary measures over time	
		<i>Case-control study</i> —Report numbers in each exposure category, or summary measures of exposure	
		<i>Cross-sectional study</i> —Report numbers of outcome events or summary measures	Page 6, Line 176-178 Page 9, line 229-231
Main results	16	(a) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	Page 7, line 199-202
		(b) Report category boundaries when continuous variables were categorized	Page 8 Table 2
		(c) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	/
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	/
Discussion			
Key results	18	Summarise key results with reference to study objectives	Page 12 Line 277-280
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	Page 3 Line 63-72
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	Page 14 Line 354-357
Generalisability	21	Discuss the generalisability (external validity) of the study results	Page 15 Line 357-360
Other information			
Funding	22	Give the source of funding and the role of the funders for the present study and, if	Page 16

applicable, for the original study on which the present article is based

Line 384-385

*Give information separately for cases and controls in case-control studies and, if applicable, for exposed and unexposed groups in cohort and cross-sectional studies.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at <http://www.plosmedicine.org/>, Annals of Internal Medicine at <http://www.annals.org/>, and Epidemiology at <http://www.epidem.com/>). Information on the STROBE Initiative is available at www.strobe-statement.org.

BMJ Open

Characteristics of online medical care consultation for pregnant women during the COVID-19 outbreak: a cross-sectional study

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Characteristics of online medical care consultation for pregnant women during the COVID-19 outbreak: a cross-sectional study

Miaomiao Chen^{1,2,a}, Xiyao Liu^{1,a}, Jun Zhang³, Guoqiang Sun², Ying Gao²,Yuan Shi⁴, Philip N. Baker⁵, Jing Zeng¹, Yangxi Zheng¹, Xin Luo^{1,*}, Hongbo Qi^{1,*}

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Abstract

Objectives: This study described the needs of pregnant women and the contents of online obstetric consultation in representative areas with various severity of the epidemic in China.

Design: This was a cross-sectional study.

Setting: YueYiTong (YYT), a free online communication platform that allows pregnant women to consult professional obstetricians.

Participants: All the pregnant women who used the YYT platform.

Intervention: From February 10th to 23rd, we collected data on online obstetric consultations and participants' satisfaction through YYT platform in the mild, moderate and severe epidemic areas which were defined according to the local confirmed cases. The primary outcomes were the reasons for online consultations by the severity of the epidemic. All the comparisons were performed using Chi-squared test. Statistical analysis was performed using SPSS V.24.

Results: A total of 2599 pregnant women participated in this study, of whom 448 (17.24%), 1332 (51.25%) and 819 (31.51%) women were from the mild, moderate and severe epidemic areas, respectively. The distribution of the amount of online consultations was significantly different not only in different areas ($p<0.001$), but also in different trimesters ($p<0.001$). Total of 957 participants completed the satisfaction part of the survey. In this study, 77.95% of the

participants used e-health for the first time, and 94.63% participants were completely or mostly satisfied with the online consultations.

Conclusions: The distribution of the amount of online consultations was significantly different not only in different areas, but also in different trimesters. In any trimester, the amount of consultations on the second category (obstetric care-seeking behaviour) was the highest in the severe epidemic areas. The needs for online consultations were substantial. In order to prevent irreversible obstetric adverse events, an appropriate antenatal care (ANC) contingency plan with e-health services is highly recommended during the Public Health Emergency of International Concern (PHEIC).

Keywords: COVID-19; pregnant women; antenatal care; e-health

Strengths and limitations

1. We collected these data during the most hopeless phase throughout the outbreak in China, and the data of Hubei province was also included.
2. Multiple centres were involved in the design to minimize biases.
3. This is a cross-sectional study with the short duration of data collection.
4. There may be bias as the satisfaction questionnaire was not a commonly structured scale.
5. Self-report bias might exist in our design.

Background

Since December 2019, a number of unexplained cases of viral pneumonia have been found in Wuhan, Hubei province.^[1] By January 7, 2020, Chinese scientists had isolated the novel coronavirus, which has been later termed as severe acute respiratory syndrome coronavirus 2

(SARS-CoV-2). The official name of the related disease is COVID-19.^[2] Since 10 a.m. on January 23, 2020, traffic bans in Wuhan has been established and the whole city has been temporarily locked down.^[3] Subsequently, first-level emergency responses to public health emergencies have been launched successively throughout China. As of April 8, 2020, the number of confirmed cases of COVID-19 globally reached 1,384,146, of which 83,157 cases were confirmed in China, especially in Hubei province (67,803 confirmed cases).

Pregnant women are considered to be susceptible to this virus.^[4] For pregnant women, the routine ANC during pregnancy is very important, by which high-risk pregnant women can be screened as soon as possible.^[5,6] However, the maternal ANC encountered great challenges during the COVID-19 outbreak due to limited accessibility of some medical resources caused by emergency traffic bans, and the risk of viral transmission. In the clinical setting, we noticed that some highly recommend antenatal check-ups had been canceled or postponed beyond its opportune gestational age by many pregnant women. And the recent studies have mainly focused on the therapeutics of pregnant women with COVID-19. Little was discussed about maternal ANC during the COVID-19 outbreak.^[7-9]

E-health refers to the integration of medical services and medical information through the Internet and mobile technologies, such as computers, mobile phones, handheld tablets, and other wireless devices.^[10,11] Compared with developed countries, e-health started relatively late in China.^[12,13] Previous reports have shown that the number of mobile phone users worldwide is nearly 7.7 billion, which equals to the total population in the world.^[14] By June 2019, only 5.27% internet users had used the “Internet+medical” (45 million).^[15] YueYiTong (YueYiTong Science and Technology Co., Ltd. in Chongqing, China) has set up an online communication platform that allows pregnant women to consult professional obstetricians without leaving home for hospitals.^[16]

In this study, we focused on the specific content of online obstetric consultation for pregnant women during the COVID-19 outbreak based on the platform (YYT). To further investigate the role of e-health, we also conducted a survey on pregnant women who consulted online to understand their satisfaction with this consultation service and their future needs for e-health .

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103 **Methods**

104 **Study design and participants**

105 This study was a descriptive, cross-sectional study. We collected data from two aspects
106 including contents of pregnant women's online obstetric consultation and satisfaction.
107 Gestational age and satisfaction degree were collected from registration information and
108 satisfaction questionnaire, respectively. The content of satisfaction questionnaire was
109 reviewed by obstetricians (Hongbo Qi and Xin Luo).

110 The free online service for obstetric consultation provided by YYT was promoted through
111 several ways, including forwarding the link of the online medical consultation service website
112 to colleagues and friends and distributing the free online treatment information. Within a few
113 days after it was launched, the free online treatment mode had attracted over 800
114 maternal-fetal medicine specialists in 347 hospitals nationwide. Every pregnant woman had
115 access to the free online treatment after registration on the platform, and can choose
116 obstetricians or hospitals at will. When a patient consults a doctor, the platform will prompt
117 the doctor to reply within 24 hours. Before the consultation, the pregnant women were
118 informed that the contents of the consultation would be used for scientific research and be
119 kept absolutely confidential. If they chose "I already know and agree to the above", they can
120 continue their free online consultations. After the consultation, the platform would distribute a
121 satisfaction questionnaire, which would take 2 minutes to complete, but pregnant women
122 could choose whether to answer or not. The study started from February 10, 2020 to February
123 23, 2020.

124 All pregnant women, who had submitted their online obstetric consultation, were eligible for
125 inclusion. The cross-sectional study was approved by the ethics committee of the First
126 Affiliated Hospital of Chongqing Medical University (20200501), and all the methods were
127 performed in accordance with the relevant guidelines and regulations.

128 **Procedures**

According to the map of national COVID-19 confirmed cases and the data we collected from each province, Xinjiang, Gansu (10-99 confirmed cases), Chongqing (100-999 confirmed cases), Hubei, Henan, and Hunan (≥ 1000 confirmed cases) were chosen as representative areas (Figure 1 and Figure 2). In this study, the number of confirmed cases of COVID-19 in different areas was used to assess the severity of epidemics (Table S1). Hence, according to the confirmed cases, Hubei, Henan and Hunan were defined as the severe epidemic areas. Chongqing was defined as the moderate epidemic area for more confirmed cases than Xinjiang and Gansu (the mild epidemic areas).

Data collection were conducted automatically and all data in our study were reviewed and classified independently by two authors (MMC and XYL). The data was sorted by different areas or different trimesters of pregnancy using manual classification method after the exclusion of unqualified data. The specific process of exclusion was shown in Figure 3.

Impossible gestational age was identified whenever last menstrual or current gestational age showing less than 0 week or more than 45 weeks gestational age. According to gestational age, participants in each representative area were divided into three gestational periods: (1) the first trimester: < 14 weeks, (2) the second trimester: from 14 weeks to 27 weeks and 6 days, (3) the third trimester: ≥ 28 weeks. At the same time, the contents of online obstetric consultations were then subdivided into five primary categories: (1) Routine antenatal check-up (reports of examination, appointments for antenatal check-up, method and time of delivery, and hospitalization process; (2) Obstetric care-seeking behaviours (cancel or postpone scheduled ANC visits; change method or time of delivery); (3) Abnormal symptoms (vaginal bleeding, abnormal fetal movement, abdominal pain, etc.); (4) Maternal comorbidities and pregnancy complications (gestational diabetes mellitus, hypertension disorders, hypothyroidism, etc.); (5) Other needs of e-health (remote fetal heart monitoring, electronic prescription, online pharmacies).

Since the satisfaction questionnaire was not a commonly structured scale, all the 7 questions have been analyzed separately. The questionnaire is shown in Appendix 1. Through the satisfaction questionnaire, we intended to understand the “4P” situation during the COVID-19

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outbreak in different areas: (1) Percentage of users who use e-health for the first time; (2) Proportion of problems solved by YYT; (3) Pregnant women’s satisfaction with e-health; (4) Preference to e-health vs outpatient visits during and after the outbreak of COVID-19.

Statistical analysis

All exact numbers and percentages for all variables were calculated, and the comparisons were performed using Chi-squared test. Logistic regression was used to examine the association between the distribution of the amount of online consultations and the trimesters. The SPSS software, version 24.0 was used for the statistics analysis, and the conventional *p* value less than 0.05 is defined as statistically significant. Percentage (%) was used to express categorical variable.

Patient and Public Involvement

We didn’t directly include patient and public involvement in the study.

Result

A total of 2599 pregnant women participated in this study, of whom 448 (17.24%), 1332 (51.25%) and 819(31.51%) women were from the mild, moderate and severe epidemic areas, respectively. Among all the participants, 417(16.04%), 1054(40.55%) and 1128(43.40%) were in their first, second and third trimester of pregnancy, respectively. It was worth noting that it was the first time e-health was used in ANC during the COVID-19 outbreak, and 6.77% of participants generated additional requirements for e-health, such as: remote fetal heart rate monitoring, electronic prescription, and online pharmacies.

Reasons for online consultations by areas with different severity of the epidemic.

As shown in [table 1](#), the distribution of the amount of online consultations varied by areas with different severity of the epidemic (*p* <0.001). And 32.48% of pregnant women consulted the second category (obstetric care-seeking behaviour) in the most severe areas, which was significantly higher than the average value of 22.58% ([Table 1](#)).

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184 *Table 1: Reasons for online consultations by areas with different severity of the epidemic.*

Classification of online medical care consultation	The severity of the epidemic situation in different areas			Total	χ^2	P-value
	Mild	Moderate	Severe			
	(n=448)	(n=1332)	(n=819)			
Routine antenatal check-up	184(41.07)	561(42.12)	263(32.11)	1008(38.78)		
Obstetric care-seeking behaviour	91(20.31)	229(17.19)	266(32.48)	586(22.55)		
Abnormal symptoms	110(24.55)	292(21.92)	143(17.46)	545(20.97)	86.216	$p<0.001^{**}$
Maternal comorbidity and pregnancy complications	46(10.27)	158(11.86)	80(9.77)	284(10.93)		
Other needs for e-health	17(3.79)	92(6.91)	67(8.18)	176(6.77)		

185 *Note: Data are n (%); Chi-squared test was used for the analysis; * $p<0.05$ ** $p<0.01$.*

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187 **Reasons for online consultations by trimesters of pregnancy.**

188 In [table 2](#), the difference was shown in the distribution of the amount of online consultations
 189 by trimesters ($p < 0.01$). The first category (routine antenatal check-up) was of highest concern
 190 in the first trimester (57.31%), compared to that in the second (39.75%) and third trimester
 191 (31.03%). While the distribution of the amount of online consultations on the second category
 192 in different trimesters were completely opposite to that on the first category. And the second
 193 category had attracted the most attention from pregnant women in the third trimester
 194 (25.18%). Compared with the distribution of the amount of online consultations on the first
 195 category, the second (OR=1.265, 95% CI 1.044 to 1.532), third (OR=1.380, 95% CI 1.134 to
 196 1.680), and forth category (OR=2.639, 95% CI 2.031 to 3.429) were associated with the

trimesters of pregnancy (Table 2).

Table 2: Reasons for online consultations by trimesters of pregnancy.

	Trimesters of pregnancy				OR (95% CI)	P-value
	First	Second	Third	Total		
	trimester	trimester	trimester			
	(n=417)	(n=1054)	(n=1128)			
Classification of online medical care consultation						<i>p</i> <0.001**
Routine antenatal check-up	239(57.31)	419(39.75)	350(31.03)	1008(38.78)	Reference(1)	
Obstetric care-seeking behaviour	45(10.79)	257(24.38)	284(25.18)	586(22.55)	1.265 (1.044 to 1.532)	0.016
Abnormal symptoms	74(17.75)	211(20.02)	260(23.05)	545(20.97)	1.380 (1.134 to 1.680)	0.001
Maternal comorbidity and pregnancy complications	28(6.71)	75(7.12)	181(16.05)	284(10.93)	2.639 (2.031 to 3.429)	<i>p</i> <0.001**
Other needs for e-health	31(7.43)	92(8.73)	53(4.70)	176(6.77)	0.742 (0.533 to 0.984)	0.039

Note: Data are n (%); OR, odds ratio; CI, confidence interval; * *p*<0.05 ** *p*<0.01.

Reasons for online consultations by the trimesters of gestation and the severity of the epidemic.

In this study, as shown in [table 3](#), most participants were in the second or third trimester (40.55%, 43.40%). Regardless of the trimesters, the distribution of the amount of online consultations was region-dependent ($p < 0.001$). In any trimester, the amount of consultations on the second category (obstetric care-seeking behaviour) was the highest in the severe epidemic areas. And the proportions of the second category in the second and third trimesters were 36.51% and 37.88% separately, while the corresponding average values were 24.38% and 25.18% ([Table3](#)).

The most concerned category during different trimesters.

Generally, in any area, or during any trimester, routine antenatal check-up, obstetric care-seeking behaviour, and abnormal symptoms were the top three consulted categories ([Figure 4](#)). In the first trimester, pregnant women in different regions were the most frequently consulting for the first type of problems, which was consistent with that in the second and third trimester both in the moderate and mild epidemic areas ([Figure 4](#)). However, in the severe epidemic areas, the second category (Obstetric care-seeking behavior) was of most concern in the second and third trimesters of pregnancy ([Figure 4](#)).

Table 3: Reasons for online consultations by the trimesters of gestation and the severity of the epidemic.

Classification of online medical care consultation	The severity of the epidemic situation in different areas			Total	χ^2	P-value
	Mild	Moderate	Severe			
	(n=448)	(n=1332)	(n=819)			
First trimester				417(16.04)	33.422	$p < 0.001^{**}$
Routine antenatal check-up	36(58.06)	125(69.06)	78(44.83)	239(57.31)		
Obstetric care-seeking behaviour	8(12.90)	11(6.08)	26(14.94)	45(10.79)		

Abnormal symptoms	16(25.81)	25(13.81)	33(18.97)	74(17.75)
Maternal comorbidity and pregnancy complications	2(3.23)	8(4.42)	18(10.34)	28(6.71)
Other needs for e-health	0(0.00)	12(6.63)	19(10.92)	31(7.43)
Second trimester				1054(40.55) 48.869 $p<0.001^{**}$
Routine antenatal check-up	86(45.99)	231(41.85)	102(32.38)	419(39.75)
Obstetric care-seeking behaviour	44(23.53)	98(17.75)	115(36.51)	257(24.38)
Abnormal symptoms	34(18.18)	133(24.09)	44(13.97)	211(20.02)
Maternal comorbidity and pregnancy complications	11(5.88)	38(6.88)	26(8.25)	75(7.12)
Other needs for e-health	12(6.42)	52(9.42)	28(8.89)	92(8.73)
Third trimester				1128(43.40) 52.766 $p<0.001^{**}$
Routine antenatal check-up	62(31.16)	205(34.22)	83(25.15)	350(31.03)
Obstetric care-seeking behaviour	39(19.60)	120(20.03)	125(37.88)	284(25.18)
Abnormal symptoms	60(30.15)	134(22.37)	66(20.00)	260(23.05)
Maternal comorbidity and pregnancy complications	33(16.58)	112(18.70)	36(10.91)	181(16.05)
Other needs for e-health	5(2.51)	28(4.67)	20(6.06)	53(4.70)

*Note: Data are n (%); Chi-squared test was used for the analysis. * $p<0.05$ ** $p<0.01$.*

Participants experience with e-health.

The participants' experience with e-health were summarized in [table 4](#). A total of 957 participants completed the satisfaction questionnaire, of whom 164(17.14%), 644(67.29%) and 149(15.57%) were from the mild, moderate and severe epidemic areas respectively.

During the outbreak of COVID-19, we wanted to learn the following four aspects of the situation in different regions ("4P") from the questionnaire. The first is the percentage of users who use e-health for the first time. Surprisingly, for most of the participants, it was their first time to use the e-health, with the highest rate of 89.26% in the severe epidemic areas. The second is the proportion of problems solved by the platform. We found that more than 90% of online consultations issues were completely or partially resolved. The third is pregnant women's satisfaction with e-health. In fact, the proportion of total satisfaction or relative satisfaction was the lowest in the severe epidemic areas, at 87.92%, while it was as high as 90% in other areas. The last was the preference to e-health or outpatient visits during and after the outbreak. Undoubtedly, the outbreak of COVID-19 had an obvious impact on participants' choices. During the outbreak of COVID-19, most participants preferred to use e-health (the lowest rate of 88.41% in the mild epidemic areas), while, about half of participants chose the outpatient visits after the outbreak, which was most popular in moderate epidemic areas, with the highest rate of 62.11%. An average of 79.94% participants deemed that e-health could save time, and 82.45% participants thought it could reduce the risk of COVID-19 infection. In addition, There were 39.81% and 41.17% participants held the view that e-health could make them feel comfortable and save money, respectively. As for their suggestions for e-health in the near future, there were 32.92%, 28.21%, 57.37%, and 47.02% participants hoping for the function of online video, physician's replay within a defined time, automatic referral to appropriate obstetricians, and management of maternal medical condition, respectively. There were 3.76% participants expressed more needs for e-health, such as remote fetal heart monitoring, electronic prescription, online pharmacies, etc.

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9 259 Table 4: Satisfaction questionnaire.

	The severity of the epidemic			Total	χ^2	P-value
	in different areas					
	Mild	Moderate	Severe			
First time using e-health	164	644	149	/	20.178	$p<0.001^{**}$
No	27(16.46)	168(26.09)	16(10.74)	211(22.05)		
Yes	137(83.54)	476(73.91)	133(89.26)	746(77.95)		
The degree of trouble shooting	164	644	149	/	23.274	0.001**
Completely solved	124(75.61)	521(80.90)	98(65.77)	743(77.64)		
Largely solved	34(20.73)	115(17.86)	42(28.19)	191(19.96)		
Barely solved	4(2.44)	6(0.93)	6(4.03)	16(1.67)		
Not solved at all	2(1.22)	2(0.31)	3(2.01)	7(0.73)		
The degree of satisfaction with e-health	164	644	149	/	22.015	0.005**
Completely satisfaction	109(66.46)	438(68.01)	82(55.03)	629(65.73)		
Mostly satisfied satisfaction	43(26.22)	175(27.17)	49(32.89)	267(27.90)		
neutral attitude	11(6.71)	25(3.88)	14(9.40)	50(5.22)		
Mostly satisfied dissatisfaction	1(0.61)	0(0.00)	2(1.34)	3(0.31)		
Completely dissatisfaction	0(0.00)	6(0.93)	2(1.34)	8(0.84)		
Choice (during the COVID-19)	164	644	149	/	1.147	0.563
E-health	145(88.41)	576(89.44)	137(91.95)	858(89.66)		
Outpatient	19 (11.59)	68(10.56)	12(8.05)	99(10.34)		

Choice (after the COVID-19)	164	644	149	/	11.145	0.004**
E-health	85(51.83)	244(37.89)	66(44.30)	395(41.27)		
Outpatient	79(48.17)	400(62.11)	83(55.70)	562(58.73)		
Convenience of the e-health^M	395	1613	351	/	6.821	0.556
Time -saving	124(75.61)	535(83.07)	106(71.14)	765(79.94)		
Risk-reduction [@]	127(77.44)	534(82.92)	128(85.91)	789(82.45)		
Cost- saving	71(43.29)	268(41.61)	55(36.91)	394(41.17)		
Feeling more relax	64(39.02)	258(40.06)	59(39.60)	381(39.81)		
Others	9(5.49)	18(2.80)	3(2.01)	30(3.13)		
Needs for e-health^M	285	1087	248	/	14.474	0.070
Online video	67(23.51)	198(18.22)	50(20.16)	315(32.92)		
Physician's replay within a defined time	52(18.25)	173(15.92)	45(18.15)	270(28.21)		
Automatic referral to appropriate obstetricians	83(29.12)	370(34.04)	96(38.71)	549(57.37)		
Management of maternal medical condition	79(27.72)	318(29.25)	53(21.37)	450(47.02)		
Others [#]	4(1.40)	28(2.58)	4(1.61)	36(3.76)		

Note: Data are n (%); * $p < 0.05$ ** $p < 0.01$; M: multiple choice allowed; Risk-reduction[@]: risk-reduction of being infected with COVID-19 by avoiding extra exposure. Others[#]: remote fetal heart monitoring, electronic prescription, or online pharmacies.

Discussion

The COVID-19 outbreak represents a significant and urgent threat to global health. On January 30, 2020, COVID-19 was declared as “public enemy number one” and “a very high level of global risk” by WHO.^[17,18] As of March 23, 2020, 186 countries worldwide had reported confirmed COVID-19 cases, including more than 10,000 confirmed cases in America, Germany, France, Italy and Iran. In this study, many pregnant women were found

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postponing or canceling their scheduled ANC visits on their own, which was related to the severity of the epidemic situation in different areas, especially in the severe epidemic areas. Meanwhile, the needs of pregnant women for e-health have exceeded our expectation. Data showed that more than 15,000 consultations were conducted through the platform till March 15. To the best of our knowledge, this is the first time to focus on the characteristics of online obstetric consultation for pregnant women during the COVID-19 outbreak. Since the majority of participants in the study was in their second and third trimester, the data of the first trimester had certain limitations.

Changes in obstetric care-seeking behaviour during the COVID-19 outbreak.

In our study, we discussed the associations between the distribution of the amount of online consultations and trimesters or the severity of the epidemic in different area. The distribution of the amount of online consultations was significantly different not only in different areas, but also in different trimesters. We also found that in any trimester, the amount of consultations on the second category (obstetric care-seeking behaviour) was the highest in the severe epidemic areas. During the COVID-19 outbreak, emergency traffic bans limited accessibility of some medical resources for pregnant women, and fear of viral transmission also prevented pregnant women from seeking routine ANC, especially in the severe epidemic areas. All of these phenomena can explain the cause of the highest concern of second category in the areas with severe epidemic. Unlike the first and the second trimester, the need for more frequent ANC in the third trimester is already a huge challenge for pregnant women.^[19] There were 16,120 outpatient visits in Obstetrics Clinic of the First Affiliated Hospital of Chongqing Medical University in last February, compared with 6,859 in February 2020. Furthermore, this difference was more dramatic in Maternal and Child Health Hospital of Hubei Province, because more than 21,000 outpatient visits were reduced in February 2020, compared with that of last February (27254 visits VS 5410 visits). The sharp decline of outpatient visits further reflected that pregnant women postponed or canceled scheduled ANC visits on their own. This phenomenon raised our concerns over a series of potential irreversible obstetric adverse events.

297 **Significance of ANC.**

298 In order to detect maternal complications, reduce adverse pregnancy events and promote
299 doctor-patient communication, 8 “contacts” is recommended during pregnancy according to
300 WHO.^[20,21] Referring to the ANC guideline developed by America, Britain, Canada, and
301 WHO, based on Chinese condition, *Guideline of Preconception and Prenatal Care (2018)*
302 which was released by Chinese Medical Association, Chapter of Perinatal Medicine
303 recommends 7-11 “contacts”.^[19] If there are high risk factors, the frequency should be
304 increased appropriately. This guideline is widely applied by almost all domestic ANC
305 institutions in China. Benefiting from the widespread application of the ANC guideline, birth
306 defects and cesarean section rates have been reduced, and many other adverse pregnancy
307 outcomes have been avoided in China.^[22-28] Nevertheless, during the COVID-19 outbreak, the
308 routine ANC for pregnant women who are considered to be susceptible are extremely
309 challenged.^[29,30] In the past month, a dramatic decline in ANC visit and an increase in the
310 cesarean section rate had been observed by obstetricians, all of which could lead to
311 irreversible obstetrical pregnancy outcome. The phenomenon might be related to the delayed
312 detection of fetal malformation and a significant increasing incidence of diabetes,
313 macrosomia and obesity due to lack of nutritional interventions or routine physical activities.
314 What’s more, some pregnant women wanted to be hospitalized earlier to wait for the onset of
315 labour or to have a cesarean in advance driven by an idea that as time went on, the chance of
316 infection would increase. On the other hand, some pregnant women with indications of
317 hospitalization blindly refused to be hospitalized for fear of infection with COVID-19. To
318 prevent irreversible obstetric adverse events, some highly recommended antenatal check-ups
319 must be conducted on time, and when it comes to conduct ultrasound examination for
320 confirming intrauterine pregnancy and Nuchal Translucency (NT) measurement, screening
321 for foetal aneuploidy, oral glucose tolerance test (OGTT), etc., pregnant women have to visit
322 hospital in person. And prompt hospitalization were highly recommended in the following
323 circumstances, approaching terminal gestational age, pregnancy with severe maternal medical
324 condition, with signs of labor, etc..

325 **A novel mode of ANC plan with full application of e-health.**

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In our survey, most of the participants experienced e-health for the first time. What’s more, 91.95% pregnant women reported that they preferred e-health rather than a visit to hospital during the COVID-19 outbreak in the severe epidemic areas. The majority of pregnant women were completely or comparatively satisfied with e-health, and most of online obstetric consultations were completely or mostly solved. Except the second category, most pregnant women are more likely to consult about the first and third category, which probably due to the familiarity of e-health among the public. This result was consistent with the report of China Internet network information center (CNNIC) in June 2019.^[13] Actually, the “e” in e-health not only stands for “electronic”, but also means telemedicine, telecare, clinical information systems, and other non-clinical systems used for education, public health, medical management and so on.^[10] E-health has made some achievements in the management of chronic diseases such as diabetes and hypertension disorders.^[31,32] The application of e-health in obstetrics is mainly reflected in the abortion of unplanned pregnancy in the first trimester.^[33] The popularity of wearable devices promotes quantitative health management.^[34] Nevertheless, “e-health” cannot save everything. Some highly recommended antenatal check-ups and timely hospitalization are still necessary. Our domestic clinical ANC guideline is divided into health education and guidance, routine health care and auxiliary examination.^[19] According to the investigation of online obstetric consultation during the COVID-19 outbreak, we recommend combining e-health with the ANC guideline in the following three aspects: (1) management of mental health, routine health education and care, authoritative prevention education on PHEs; (2) auxiliary procedures done through e-health for necessary check-ups recommended in hospital by obstetricians, such as making appointments, consulting examination reports etc.; (3) interventions of some maternal medical conditions performed through e-health, including gestational diabetes mellitus, hypertension disorders, etc., which had been fully applied in non-pregnant people.^[31] We hold that the full application of e-health and prenatal care is highly recommended to be included in the contingency ANC plan during PHEs, which will be beneficial for pregnant women and mitigate the risk of adverse pregnancy outcomes.

Conclusions

Our study found that during the outbreak, many pregnant women changed their scheduled antenatal care (ANC) visits without obstetrician's authorization, especially in the severe epidemic areas. This study also revealed that online obstetric consultation is highly accepted and greatly satisfied the pregnant women during the COVID-19 outbreak in China. This investigation also indicated that e-health has played an important role in ANC during PHE. This novel model of ANC plan can make notable contributions not only in China, but also in other emerging epidemic centers worldwide and in future PHEs.

List of abbreviations

Coronavirus Disease 2019: COVID-19;

Antenatal care: ANC;

“YunYiTong WeChat terminal service”: YYT;

Public Health Emergency of International Concern: PHEIC;

Severe acute respiratory syndrome coronavirus 2: SARS-CoV-2;

World Health Organization: WHO;

China Internet network information center: CNNIC.

Declarations

Ethics approval and consent to participate

The cross-sectional study was approved by the ethics committee of the First Affiliated Hospital of Chongqing Medical University (20200501).

Consent for publication

We followed guidelines ensuring the study was voluntary and confidential, and an electronic informed consent was obtained before the questionnaire.

Availability of data and materials

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The datasets used and analysed during the current study are available from the corresponding author on reasonable request.

Competing interests

The authors declare that they have no competing interests.

There aren't conflicts of interests or financial affiliations with YueYiTong Science and Technology Co., Ltd.

Funding

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Authors' contributions

HBQ, XL and MMC contributed to the protocol design. MMC and XYL collected and analyzed data. MMC drafted the manuscript, JZ (Jun Zhang), GQS, YG, YS, and PB contributed to the interpretation of results. JZ (Jing Zeng) and YXZ proofread and commented on the manuscript. HBQ and XL revised the final version and are guarantors of this manuscript. All authors made substantial contributions to the paper and read and approved the final manuscript.

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Not applicable.

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Figure legend

- Figure 1: The map of confirmed cases of COVID-19 in China on February 23.
- Figure 2: The map of participants' number in our study.
- Figure 3: Process of classification and exclusion.
- Figure 4: The proportion of the 5 categories by trimesters in each area.

Figure 1: The map of confirmed cases of COVID-19 in China on February 23

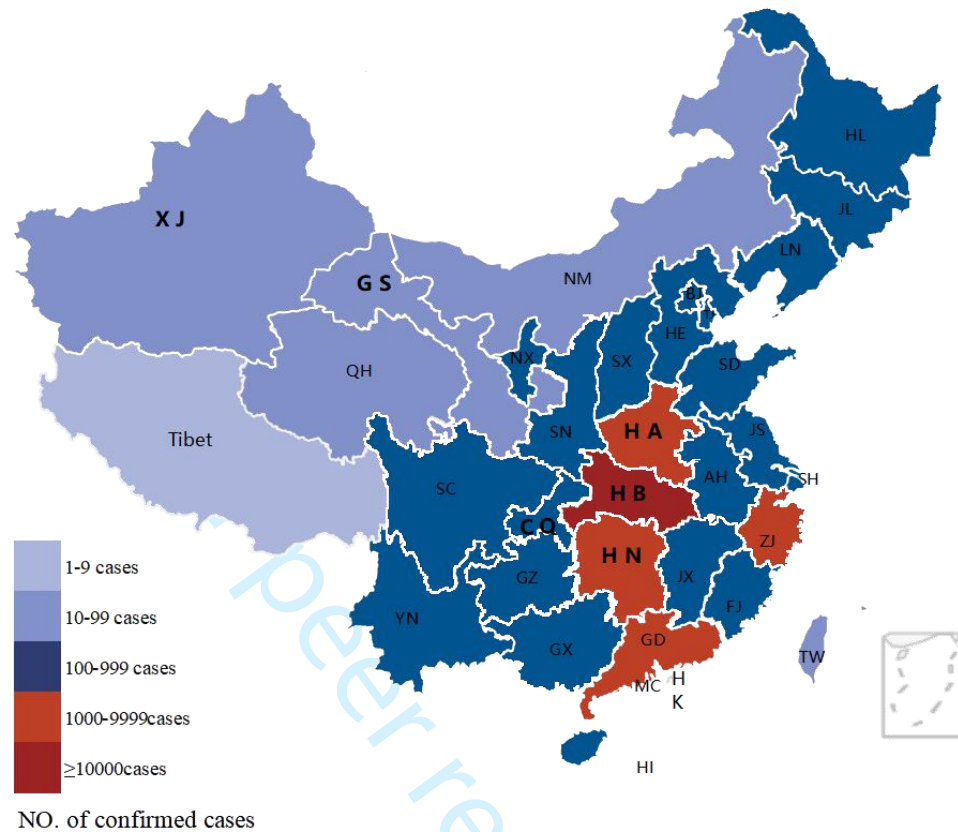


Figure 2: The map of participants' number in our study

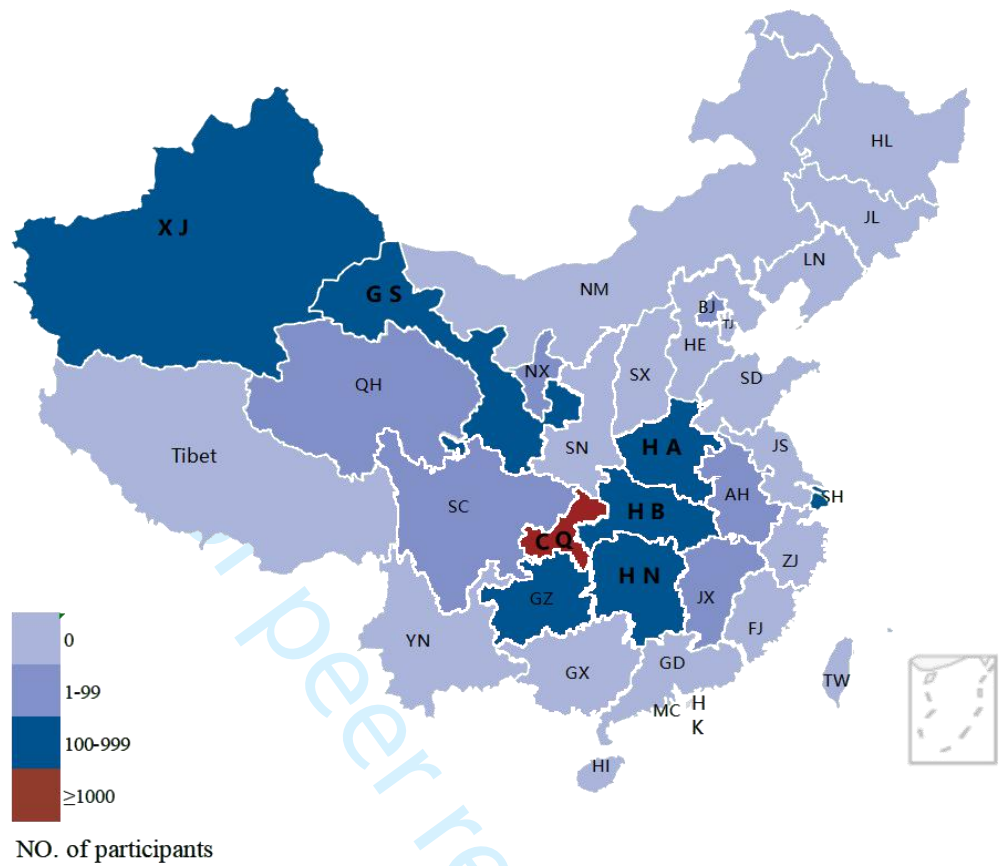


Figure 3: Process of classification and exclusion.

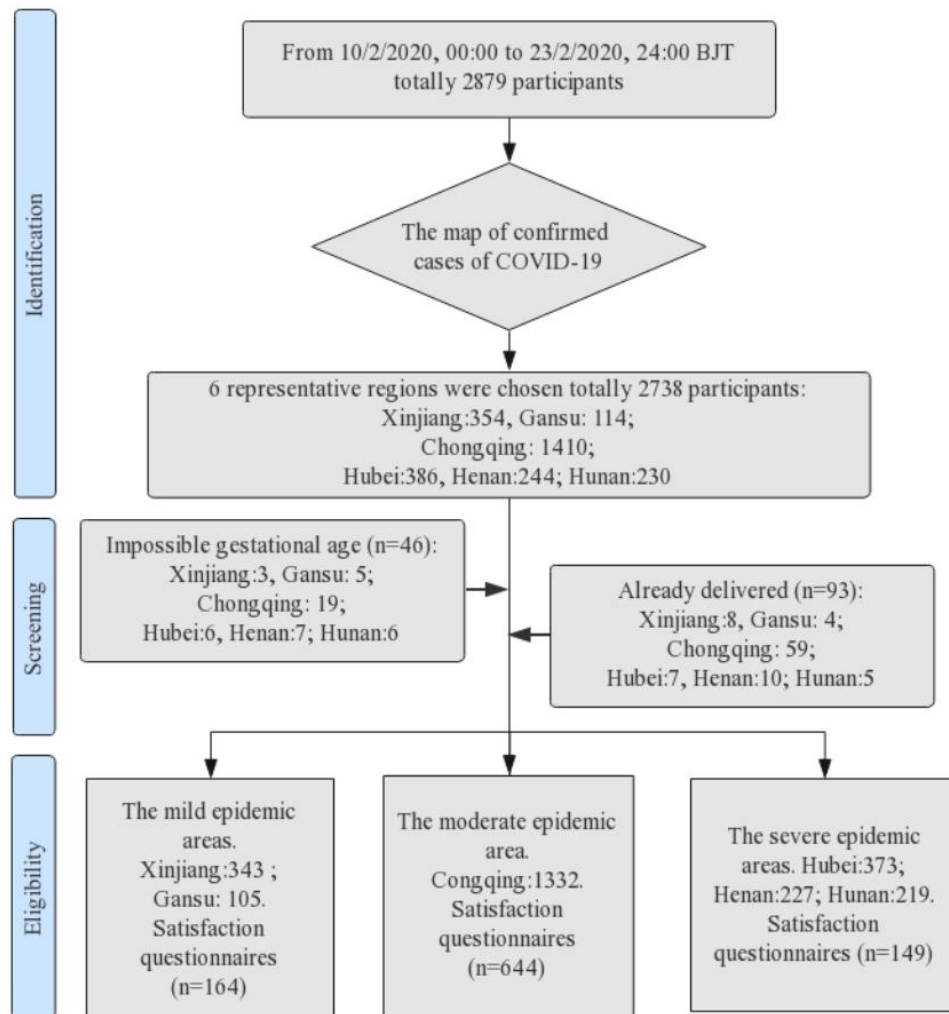


Figure 4: The proportion of the 5 categories by trimesters in each area

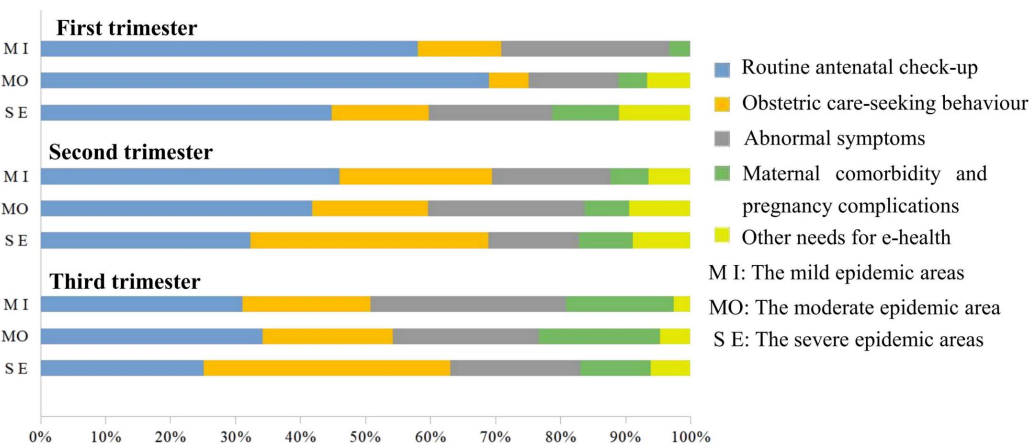


Table S1: confirmed cases in the selected areas as at the time of data collection.

The severity of the epidemic situation	Representative areas	Confirmed cases (cases)
Mild	Gansu	91
	Xinjiang	76
Moderate	Chongqing	575
	Hubei	64287
Severe	Henan	1271
	Hunan	1261

Characteristics of online medical care consultation for pregnant women during the COVID-19 outbreak: a cross-sectional study

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Appendix 1: Satisfaction questionnaire survey

Notice:

1. This is the translated version (from Chinese to English) of the questionnaire.
2. This is merely the main content of the questionnaire, not covering the brief introduction, the tips for filling in and the acknowledgments.
3. Unless otherwise mentioned, the questions are single-choice questions with options below or blank-filling questions with a horizontal line.

1. Is you first time using e-health ?

A: Yes

B: No

2. Had your online medical consultation been solved ?

A: Completely solved

B: Largely solved

C: Barely solved

D: Not solved at all

3. Are you satisfied with this online medical service?

A: Completely satisfaction

B: Mostly satisfaction

C: Neutral attitude

D: Mostly dissatisfaction

E: Completely dissatisfaction

4. What convenience do you think e-health brings to you? (multiple choices)

A: Time -saving

B: Reducing risk of being infected with COVID-19

C: Cost- saving

D: Feeling more relax

5. What other functions do you hope e-health can provide for you? (multiple choices)

A: Online video

B: Physician's replay within a defined time

C: Automatic referral to appropriate obstetricians²

D: Management of chronic diseases (diabetes, hypertension disorders, etc.)

E: Others (remote fetal heart monitoring, electronic prescription, or online pharmacies)

6. During the outbreak of COVID-19, which one do you prefer ?

A: E-health

B: outpatient

7. After the COVID-19, which one do you prefer ?

A: E-health

B: outpatient

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STROBE Statement—checklist of items that should be included in reports of observational studies

	Item No	Recommendation	
Title and abstract	1	(a) Indicate the study’s design with a commonly used term in the title or the abstract	Page 1, line 1-2
		(b) Provide in the abstract an informative and balanced summary of what was done and what was found	Page 2, line 32-57
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	Page 3, line 74-101
Objectives	3	State specific objectives, including any prespecified hypotheses	Page 3, line 102-105
Methods			
Study design	4	Present key elements of study design early in the paper	Page 2, line 60
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	Page 4-5, line 108-127;
Participants	6	(a) Cohort study—Give the eligibility criteria, and the sources and methods of selection of participants. Describe methods of follow-up	Page 5, line128-129.
		Case-control study—Give the eligibility criteria, and the sources and methods of case ascertainment and control selection. Give the rationale for the choice of cases and controls	
		Cross-sectional study—Give the eligibility criteria, and the sources and methods of selection of participants	
		(b) Cohort study—For matched studies, give matching criteria and number of exposed and unexposed	/
		Case-control study—For matched studies, give matching criteria and the number of controls per case	
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	Page 5, line 136-140;

Page 5-6,
line 145-157.

Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	Page 4, line 109-110; Page 5, line 141-144.
Bias	9	Describe any efforts to address potential sources of bias	Page 3, line 71
Study size	10	Explain how the study size was arrived at	Page 5, line 133-136
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	Page 6, line 166
Statistical methods	12	(a) Describe all statistical methods, including those used to control for confounding	Page 6, line 167-168
		(b) Describe any methods used to examine subgroups and interactions	Page 6, line 168
		(c) Explain how missing data were addressed	/
		(d) <i>Cohort study</i> —If applicable, explain how loss to follow-up was addressed	/
		<i>Case-control study</i> —If applicable, explain how matching of cases and controls was addressed	
		<i>Cross-sectional study</i> —If applicable, describe analytical methods taking account of sampling strategy	
		(e) Describe any sensitivity analyses	/

Continued on next page

Results

Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	Figure 3
		(b) Give reasons for non-participation at each stage	Figure 3
		(c) Consider use of a flow diagram	Figure 3

Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	Page 6, Line 175-178
		(b) Indicate number of participants with missing data for each variable of interest	Figure 3
		(c) <i>Cohort study</i> —Summarise follow-up time (eg, average and total amount)	
Outcome data	15*	<i>Cohort study</i> —Report numbers of outcome events or summary measures over time	
		<i>Case-control study</i> —Report numbers in each exposure category, or summary measures of exposure	
		<i>Cross-sectional study</i> —Report numbers of outcome events or summary measures	Page 6, Line 176-178 Page 9, line 229-231
Main results	16	(a) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	Page 7, line 199-202
		(b) Report category boundaries when continuous variables were categorized	Page 8 Table 2
		(c) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	/
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	/
Discussion			
Key results	18	Summarise key results with reference to study objectives	Page 12 Line 277-280
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	Page 3 Line 63-72
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	Page 14 Line 354-357
Generalisability	21	Discuss the generalisability (external validity) of the study results	Page 15 Line 357-360
Other information			
Funding	22	Give the source of funding and the role of the funders for the present study and, if	Page 16

applicable, for the original study on which the present article is based

Line 384-385

*Give information separately for cases and controls in case-control studies and, if applicable, for exposed and unexposed groups in cohort and cross-sectional studies.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at <http://www.plosmedicine.org/>, Annals of Internal Medicine at <http://www.annals.org/>, and Epidemiology at <http://www.epidem.com/>). Information on the STROBE Initiative is available at www.strobe-statement.org.